















SMITHSONIAN

MISCELLANEOUS COLLECTIONS.

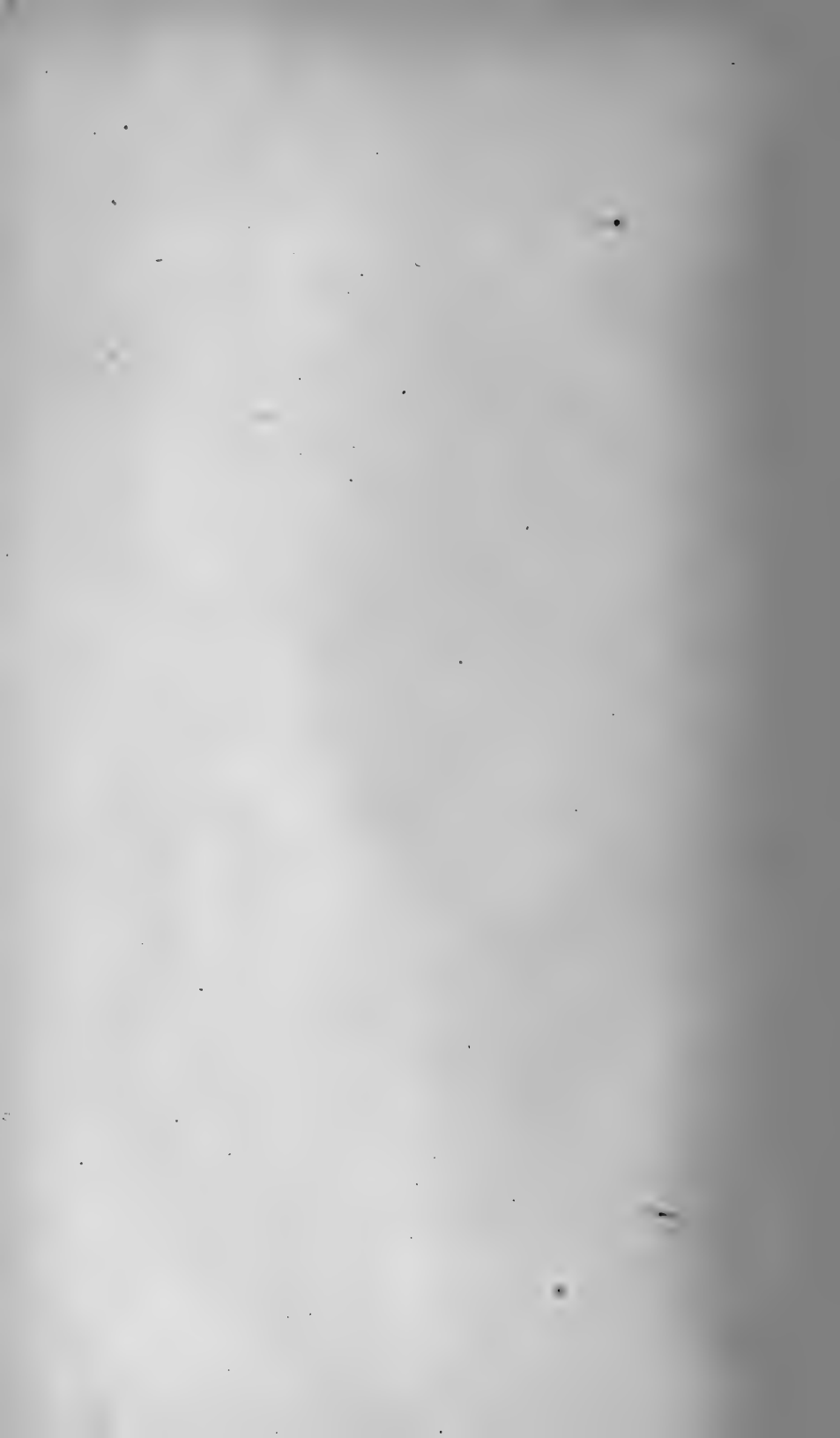
VOL. XXV.



"EVERY MAN IS A VALUABLE MEMBER OF SOCIETY WHO BY HIS OBSERVATIONS, RESEARCHES,
AND EXPERIMENTS PROCURES KNOWLEDGE FOR MEN."—SMITHSON.

Cata.

WASHINGTON:
PUBLISHED BY THE SMITHSONIAN INSTITUTION.
1883.



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The present series, entitled "Smithsonian Miscellaneous Collections," is intended to embrace all the publications issued directly by the Smithsonian Institution in octavo form; those in quarto constituting the "Smithsonian Contributions to Knowledge." The quarto series includes memoirs, embracing the records of extended original investigations and researches, resulting in what are believed to be new truths, and constituting positive additions to the sum of human knowledge. The octavo series is designed to contain reports on the present state of our knowledge of particular branches of science; instructions for collecting and digesting facts and materials for research; lists and synopses of species of the organic and inorganic world; museum catalogues; reports of explorations; aids to bibliographical investigations, etc., generally prepared at the express request of the Institution, and at its expense.

The assignment of a work to one or the other of the two series will sometimes depend upon whether the required illustrations can be presented more conveniently in the quarto or the octavo form.

In the Smithsonian Contributions to Knowledge, as well as in the present series, each article is separately paged and indexed, and the actual date of its publication is that given on its special title page, and not that of the volume in which it is placed. In many cases works have been published, and largely distributed, years before their combination into volumes.

While due care is taken on the part of the Smithsonian Institution to insure a proper standard of excellence in its publications, it will be readily understood that it cannot hold itself responsible for the facts and conclusions of the authors, as it is impossible in most cases to verify their statements.

S. F. BAIRD,
Secretary S. I.

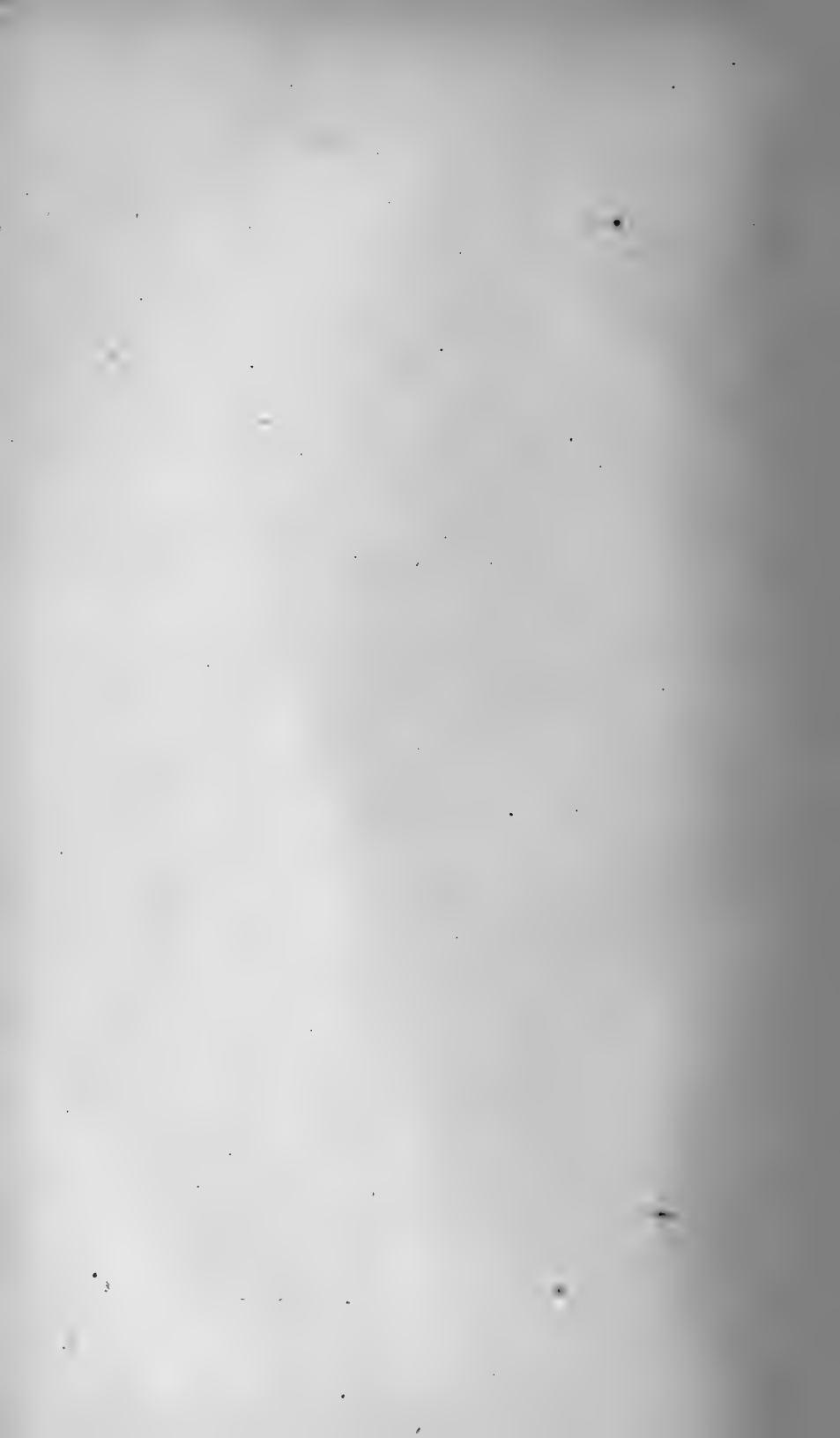


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OF THE
PHILOSOPHICAL SOCIETY
OF
WASHINGTON.

VOL. IV.

Containing the Minutes of the Society from the 185th Meeting,
October 9, 1880, to the 202d Meeting, June 11, 1881.

PUBLISHED BY THE CO-OPERATION OF THE SMITHSONIAN INSTITUTION.

WASHINGTON:

1881.

JUDD & DETWEILER,
PRINTERS,
WASHINGTON, D. C.

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CONSTITUTION

OF

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

ARTICLE I. The name of this Society shall be THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

ARTICLE II. The officers of the Society shall be a President, four Vice-Presidents, a Treasurer, and two Secretaries.

ARTICLE III. There shall be a General Committee, consisting of the officers of the Society and nine other members.

ARTICLE IV. The officers of the Society and the other members of the General Committee shall be elected annually by ballot; they shall hold office until their successors are elected, and shall have power to fill vacancies.

ARTICLE V. It shall be the duty of the General Committee to make rules for the government of the Society, and to transact all its business.

ARTICLE VI. This constitution shall not be amended except by a three-fourths vote of those present at an annual meeting for the election of officers, and after notice of the proposed change shall have been given in writing at a stated meeting of the Society at least four weeks previously.



STANDING RULES

FOR THE GOVERNMENT OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON.

JANUARY, 1881.

1. The Stated Meetings of the Society shall be held at 8 o'clock P. M. on every alternate Saturday ; the place of meeting to be designated by the General Committee.

2. Notice of the time and place of meeting shall be sent to each member by one of the Secretaries.

When necessary, Special Meetings may be called by the President.

3. The Annual Meeting for the election of officers shall be the last stated meeting in the month of December.

The order of proceedings (which shall be announced by the Chair) shall be as follows :

First, the reading of the minutes of the last Annual Meeting.

Second, the presentation of the annual reports of the Secretaries, including the announcement of the names of members elected since the last annual meeting.

Third, the presentation of the annual report of the Treasurer.

Fourth, the announcement of the names of members who having complied with Section 12 of the Standing Rules, are entitled to vote on the election of officers.

Fifth, the election of President.

Sixth, the election of four Vice-Presidents.

Seventh, the election of Treasurer.

Eighth, the election of two Secretaries.

Ninth, the election of nine members of the General Committee.

Tenth, the consideration of Amendments to the Constitution of

the Society, if any such shall have been proposed in accordance with Article VI of the Constitution.

Eleventh, the reading of the rough minutes of the meeting.

4. Elections of officers are to be held as follows:

In each case nominations shall be made by means of an informal ballot, the result of which shall be announced by the Secretary; after which the first formal ballot shall be taken.

In the ballot for Vice-Presidents, Secretaries, and Members of the General Committee, each voter shall write on one ballot as many names as there are officers to be elected, viz., four on the first ballot for Vice-Presidents, two on the first for Secretaries, and nine on the first for Members of the General Committee; and on each subsequent ballot as many names as there are persons yet to be elected; and those persons who receive a majority of the votes cast shall be declared elected.

If in any case the informal ballot result in giving a majority for any one, it may be declared formal by a majority vote.

5. The Stated Meetings, with the exception of the annual meeting, shall be devoted to the consideration and discussion of scientific subjects.

The Stated Meeting next preceding the Annual Meeting shall be set apart for the delivery of the President's Annual Address.

6. Sections representing special branches of science may be formed by the General Committee upon the written recommendation of twenty members of the Society.

7. Persons interested in science, who are not residents of the District of Columbia, may be present at any meeting of the Society, except the annual meeting, upon invitation of a member.

8. Similar invitations to residents of the District of Columbia, not members of the Society, must be submitted through one of the Secretaries to the General Committee for approval.

9. Invitations to attend during three months the meetings of the Society and participate in the discussion of papers, may, by a vote of nine members of the General Committee, be issued to persons nominated by two members.

10. Communications intended for publication under the auspices of the Society shall be submitted in writing to the General Committee for approval.

11. New members may be proposed in writing by three members of the Society for election by the General Committee: but no person shall be admitted to the privileges of membership unless he signifies his acceptance thereof in writing within two months after notification of his election.

12. Each member shall pay annually to the Treasurer the sum of five dollars, and no member whose dues are unpaid shall vote at the annual meeting for the election of officers, or be entitled to a copy of the Bulletin.

In the absence of the Treasurer, the Secretary is authorized to receive the dues of members.

The names of those two years in arrears shall be dropped from the list of members.

Notice of resignation of membership shall be given in writing to the General Committee through the President or one of the Secretaries.

13. The fiscal year shall terminate with the Annual Meeting.

14. Members who are absent from the District of Columbia for more than twelve months may be excused from payment of the annual assessments, in which case their names shall be dropped from the list of members. They can, however, resume their membership by giving notice to the President of their wish to do so.

15. Any member not in arrears may, by the payment of one hundred dollars at any one time, become a life member, and be relieved from all further annual dues and other assessments.

All moneys received in payment of life membership shall be invested as portions of a permanent fund, which shall be directed solely to the furtherance of such special scientific work as may be ordered by the General Committee.



STANDING RULES

OF THE

GENERAL COMMITTEE OF THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

JANUARY, 1881.

1. The President, Vice-Presidents, and Secretaries of the Society shall hold like offices in the General Committee.

2. The President shall have power to call special meetings of the Committee, and to appoint Sub-Committees.

3. The Sub-Committees shall prepare business for the General Committee, and perform such other duties as may be entrusted to them.

4. There shall be two Standing Sub-Committees; one on Communications for the Stated Meetings of the Society, and another on Publications.

5. The General Committee shall meet at half-past seven o'clock on the evening of each Stated Meeting, and by adjournment at other times.

6. For all purposes except for the amendment of the Standing Rules of the Committee or of the Society, and the election of members, six members of the Committee shall constitute a quorum.

7. The names of proposed new members recommended in conformity with Section 11 of the Standing Rules of the Society, may be presented at any meeting of the General Committee, but shall lie over for at least four weeks before final action, and the concur-

rence of twelve members of the Committee shall be necessary to election.

The Secretary of the General Committee shall keep a chronological register of the elections and acceptances of members.

8. These Standing Rules, and those for the government of the Society, shall be modified only with the consent of a majority of the members of the General Committee.

R U L E S
FOR THE
PUBLICATION OF THE BULLETIN
OF THE
PHILOSOPHICAL SOCIETY OF WASHINGTON.
JANUARY, 1881.

1. The President's annual address shall be published in full.
2. The annual reports of the Secretaries and of the Treasurer shall be published in full.
3. When directed by the General Committee, any communication may be published in full.
4. Abstracts of papers and remarks on the same will be published, when presented to the Secretary by the author in writing within two weeks of the evening of their delivery, and approved by the Committee on Publications. Brief abstracts prepared by one of the Secretaries and approved by the Committee on Publications may also be published.
5. Communications which have been published elsewhere, so as to be generally accessible, will appear in the Bulletin by title only, but with a reference to the place of publication, if made known in season to the Committee on Publications.

NOTE. *The attention of members to the above rules is specially requested.*

OFFICERS

OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON FOR THE YEAR 1881.

President-----JOSEPH JANVIER-WOODWARD.

Vice-Presidents-----J. K. BARNES, W. B. TAYLOR,

 J. E. HILGARD, J. C. WELLING.

Treasurer-----CLEVELAND ABBE.

Secretaries-----C. E. DUTTON, T. N. GILL.

MEMBERS OF THE GENERAL COMMITTEE.

THOMAS ANTISELL,

GARRICK MALLERY,

JOHN R. EASTMAN,

SIMON NEWCOMB,

E. B. ELLIOTT,

JOHN W. POWELL,

WILLIAM HARKNESS,

CHARLES A. SCHOTT.

JOSEPH M. TONER,

STANDING COMMITTEES.

On Communications:

C. E. DUTTON,

GARRICK MALLERY.

On Publications:

S. F. BAIRD,

T. N. GILL,

C. ABBE,

C. E. DUTTON.

LIST OF MEMBERS

OF

THE PHILOSOPHICAL SOCIETY OF WASHINGTON,

Corrected to July 18th, 1881.

The names of the Founders of the Society, March 13, 1871, are printed in small capitals; for other members the dates of election are given.

§ indicates a life member by payment of 100 dollars.

* indicates absent from the District of Columbia, and excused from dues until announcing their return.

** indicates resigned.

? indicates dropped for non-payment of dues, or nothing known of him.

† indicates deceased.

N. B.—It is scarcely possible for the Treasurer to keep a correct record of those who are absent and excused from paying dues, unless members will keep him duly notified of their removals.

THOMAS ANTISELL.

Cleveland Abbe 1871, October 29.

Benjamin Alvord 1872, March 23.

Asa O. Aldis 1873, March 1.

Sylvanus Thayer Abert 1875, January 30.

Robert Stanton Avery 1879, October 11.

SPENCER FULLERTON BAIRD.

JOSEPH K. BARNES.

STEPHEN VINCENT BENÉT.

JOHN SHAW BILLINGS.

Orville Elias Babcock 1871, June 9.

Henry Hobart Bates 1871, November 4.

† Theodorus Bailey 1873, March 1.

Thomas W. Bartley 1873, March 29.

Samuel Clagett Bussey 1874, January 17.

Emil Bessels	1875, January 16.
George Bancroft	1875, January 30.
* Lester A. Beardslee	1875, February 27.
* Rogers Birnie	1876, March 11.
Marcus Baker	1876, December 2.
Swan Moses Burnett	1879, March 29.
Alexander Graham Bell	1879, March 29.
William Birney	1879, March 29.
Horatio Chapin Burchard	1879, May 10.

HORACE CAPRON.

THOMAS LINCOLN CASEY.

† SALMON PORTLAND CHASE.

JOHN HUNTINGTON CRANE COFFIN.

† BENJAMIN FANEUIL CRAIG.

CHARLES HENRY CRANE.

Richard Dominicus Cutts	1871, April 29.
* Augustus L. Case	1872, November 16.
Robert Craig	1873, January 4.
Elliott Coues	1874, January 17.
Josiah Curtis	1874, March 28.
John White Chickering	1874, April 11.
* Frank Wigglesworth Clarke	1874, April 11.
Edward Clark	1877, February 24.
Frederick Collins	1879, October 21.
Thomas Craig	1879, November 22.
John Henry Comstock	1880, February 14.
Alexander Smythe Christie	1880, December 4.

WILLIAM HEALEY DALL.

† ALEXANDER B. DYER.

Clarence Edward Dutton	1872, January 27.
† Richard Crain Dean	1872, April 23.
Henry Harrison Chaso Dunwoody	1873, December 20.
† Charles Henry Davis	1874, January 17.
† Frederic William Dorr	1874, January 17.
Myrick Hascall Doolittle	1876, February 12.
** George Dewey	1879, February 16.
Charles Henry Davis	1880, June 19.
Theodore Lewis DeLand	1880, December 18.
† AMOS BEEBE EATON.	

EZEKIEL BROWN ELLIOTT.

** GEORGE H. ELLIOT.

John Robie Eastman	1871, May 27.
* Stewart Eldredge	1871, June 9.
Fredric Miller Endlich	1873, March 1.
? Charles Ewing	1874, January 17.

* Hugh Ewing-----1874, January 17.
John Eaton-----1874, May 8.

* ELISHA FOOTE.

William Ferrel-----1872, November 16.
Edgar Frisby-----1872, November 16.
† John Gray Foster-----1873, January 18.
Edward T. Fristoe-----1873, March 29.
Robert Fletcher-----1873, April 10.
Edward Jessop Farquhar-----1876, February 12.

THEODORE NICHOLAS GILL.

* BENJAMIN FRANKLIN GREEN.

Henry Goodfellow-----1871, November 4.
Grove Karl Gilbert-----1873, June 7.
Leonard Dunnell Gale-----1874, January 17.
* James Terry Gardner-----1874, January 17.
George Brown Goode-----1874, January 31.
Henry Gannett-----1874, April 11.
* Edward Oziel Graves-----1874, April 11.
Edward Miner Gallaudet-----1875, February 27.
Francis Vinton Greene-----1875, April 10.
Francis Mathews Green-----1875, November 9.
Edward Goodfellow-----1875, December 18.
Alexander Young P. Garnett-----1878, March 16.
* Walter Hayden Graves-----1878, May 25.
* Francis Mackall Gunnell-----1879, February 1.
Bernard Richardson Green-----1879, February 15.
William Whiting Godding-----1879, March 29.
James Howard Gore-----1880, March 14.
* Adolphus W. Greely-----1880, June 19.
Albert Leary Gihon-----1880, December 18.

ASAPH HALL.

WILLIAM HARKNESS.

FERDINAND VANDEVEER HAYDEN.

† JOSEPH HENRY.

JULIUS ERASMUS HILGARD.

ANDREW ATKINSON HUMPHREYS.

Henry W. Howgate-----1873, January 18.
* Edward Singleton Holden-----1873, June 21.
† Isaiah Hanscom-----1873, December 20.
* Edwin Eugene Howell-----1874, January 31.
Henry Wetherbee Henshaw-----1874, April 11.
David Lowe Huntingdon-----1877, December 21.
George William Hill-----1879, February 1.

*Peter Conover Hains	1879, February 15.
*Franklin Benjamin Hough	1879, March 29.
William Henry Holmes	1879, March 29.*
Ferdinand H. Hassler	1880, May 8.
William B. Hazen	1881.

THORNTON ALEXANDER JENKINS.

William Waring Johnston	1873, June 21.
* Henry Arundel Lambe Jackson	1875, January 30.
William Nicolson Jeffers	1877, February 24.
Arnold Burgess Johnson	1878, January 19.
Joseph Taber Johnson	1879, March 29.
Owen James	1880, January 3.

* Reuel Keith	1871, October 29.
John Jay Knox	1874, May 8.
Albert Freeman Africanus King	1875, January 16.
† Ferdinand Kampf	1875, December 18.
** Clarence King	1879, May 10.
Jerome H. Kidder	1880, May 8.
Charles Evans Kilbourne	1880, June 19.

† JONATHAN HOMER LANE.

Nathan Smith Lincoln	1871, May 27.
** Henry H. Lockwood	1871, October 29.
** Stephen C. Lyford	1873, January 18.
William Lee	1874, January 17.
* Edward Phelps Lull	1875, December 4.
Eben Jenks Loomis	1880, February 14.

† FIELDING BRADFORD MEEK.

MONTGOMERY CUNNINGHAM MEIGS.

† ALBERT J. MYER.

William Myers	1871, June 23.
† Oscar A. Mack	1872, January 27.
William Manuel Mew	1873, December 20.
† Archibald Robertson Marvine	1874, January 31.
† James William Milner	1874, January 31.
Garrick Mallery	1875, January 30.
Otis Tufton Mason	1875, January 30.
William McMurtrie	1876, February 26.
Aniceto Gabriel Menocal	1877, February 24.
Martin Ferdinand Morris	1877, February 24.
* Montgomery Meigs	1877, March 24.
* Joseph Badger Marvin	1878, May 25.
Fredrick Bauders McGuire	1879, February 15.
? Clay Macauley	1880, January 3.

SIMON NEWCOMB.

WALTER LAMB NICHOLSON.

* Charles Henry Nichols ----- 1872, May 4.

Charles Nordhoff ----- 1879, May 10.

† GEORGE ALEXANDER OTIS.

John Walter Osborne ----- 1878, December 7.

JOHN GRUBB PARKE.

PETER PARKER.

* TITIAN RAMSAY PEALE.

† BENJAMIN PIERCE.

Charles Christopher Parry ----- 1871, May 13.

** Carlisle P. Patterson ----- 1871, November 17.

* Charles Sanders Pierce ----- 1873, March 1.

Orlando Metcalf Poe ----- 1873, October 4.

John Wesley Powell ----- 1874, January 17.

** David Dixon Porter ----- 1874, April 11.

* Albert Charles Peale ----- 1874, April 11.

Robert Lawrence Packard ----- 1875, February 27.

Henry Martyn Paul ----- 1877, May 19.

* Henry Smith Pritchett ----- 1879, March 29.

Daniel Webster Prentiss ----- 1880, January 3.

* Christopher Raymond Perry Rodgers ----- 1872, March 9.

* Joseph Addison Rogers ----- 1872, March 9.

John Rodgers ----- 1872, November 16.

* Henry Reed Rathbone ----- 1874, January 17.

* Robert Ridgway ----- 1874, January 31.

† John Campbell Riley ----- 1877, May 19.

Charles Valentine Riley ----- 1878, November 9.

William Francis McKnight Ritter ----- 1879, October 21.

BENJAMIN FRANKLIN SANDS.

† GEORGE CHRISTIAN SCHAEFFER.

CHARLES ANTHONY SCHOTT.

WILLIAM TUCUMSEH SHERMAN.

James Hamilton Saville ----- 1871, April 29.

Ainsworth Rand Spofford ----- 1872, January 27.

? Frederic Adolphus Sawyer ----- 1873, October 4.

John Sherman ----- 1874, January 17.

* John Stearns ----- 1874, March 28.

* Ormond Stone ----- 1874, March 28.

? Aaron Nicholas Skinner ----- 1875, February 27.

Samuel Shellabarger ----- 1875, April 10.

David Smith ----- 1876, December 2.

Edwin Smith ----- 1880, October 23.

* Montgomery Sicard	1877, February 24.
Henry Robinson Searle	1877, December 21.
Charles Dwight Sigsbee	1879, March 1. •
John Patten Story	1880, June 19.

WILLIAM BOWER TAYLOR.

William Calvin Tilden	1871, April 29.
? George Taylor	1873, March 1.
Joseph Meredith Toner	1873, June 7.
Almon Harris Thompson	1875, April 10.
William J. Twining	1878, November 23.
David P. Todd	1878, November 23.

** Jacob Kendrick Upton	1878, February 2.
Winslow Upton	1880, December 4.

George Vasey	1875, June 5.
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* JUNIUS B. WHEELER.

JOSEPH JANVIER WOODWARD.

William Maxwell Wood	1871, December 2.
Francis Amasa Walker	1872, January 27.
James Clarke Welling	1872, November 16.
James Ormond Wilson	1873, March 1.
* George M. Wheeler	1873, June 7.
* John Maynard Woodworth	1874, January 21.
Allen D. Wilson	1874, April 11.
? Charles Warren	1874, May 8.
* Joseph Wood	1875, January 16.
* Christopher Columbus Wolcott	1875, February 27.
Lester Frank Ward	1876, November 18.
Charles Abiathar White	1876, December 16.
Zebulon L. White	1880, June 19.
William Crawford Winlock	1880, December 4.

† Mordecai Yarnall	1871, April 29.
Henry Crissey Yarrow	1874, January 31.

Anton Zumbrock	1875, January 30.
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BULLETIN

OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON.

185TH MEETING.

OCTOBER 9, 1880.

The President in the Chair.

The minutes of the last meeting were read and adopted.

The President notified the meeting of the decease of Prof. PEIRCE' whereupon

Mr. ELLIOTT moved the appointment of a committee of three, to be appointed by the Chair, to draft resolutions in accordance with the notice just given and submit the same at the next meeting.

The Chair appointed as Committee: J. E. HILGARD, J. H. C. COFFIN, and WM. FERRELL.

The treasurer notified the meeting that Vol. 3 of the Bulletin had been published, and that a copy would be forwarded to all members not in arrears.

Mr. C. ABBE communicated the first part of a paper on the Aurora Borealis, referring to studies made by him on the appearance of the aurora of April 4, 1874. He spoke of the difficulty which beset the consideration of the explanation of the appearance of the aurora, and especially of obtaining the altitude of the arch. The present modes of measuring the height yield only negative results, as shown by the experiments of Bravais and Martin, using the trigonometrical method. The second mode employs the varying amount of dip at separate localities, using it according to Galles' method, which assumes the dip of the needle to be of the same amount in the upper regions of the air as at the earth's surface, which has not been proved. Mr. Abbe also referred to Gauss' formula for calculating the direction and intensity of magnetism for all localities, and the defects in Galles' method of calculating the

heights of auroras, and concluded that we should look with doubt upon all results obtained.

Mr. ABBE then alluded to a third method which has been used by Prof. Newton: this method is based on the assumption that the Aurora describes an arc running round the earth in a circle parallel to the region of greatest frequency of the aurora; this method involves too many assumptions to justify its adoption. It seems impossible to obtain harmonious results from observations at one locality compared with another; nor can the results be made to harmonize with the three methods.

Mr. ELLIOTT alluded to a generally accepted belief that auroras exist at variable heights in the atmosphere, and synchronous with its existence disturbance of the magnetic needle occurs and great electric disturbance, shown by the irregular working of telegraphic apparatus. In the high regions of the air the currents encounter much less resistance than at the earth level.

Mr. OSBORNE made remarks on observations made by him on auroras at Melbourne, and on the appearances of the magnetic light in the southern hemisphere.

Mr. POWELL considered that auroras could occasionally appear in the lower strata of the atmosphere, and referred to an observation of his own in which the arch was placed between the observer and a mountain.

Mr. FARQUHAR called attention to the frequent accounts given of the occurrence of the aurora at low levels in high latitudes (as in Norway;) and as regards the direction of the flashing of the rays as proceeding from below upwards or *vice versa*, this might be an error of observation, similar to observations on the direction of currents or direction of electric light or of magnetism.

The President remarked in closing the discussion that more careful and systematic observations were necessary to determine the height and position of the auroral streamers, and to substantiate the conclusion that the same streamers could not be seen by observers a few miles apart. He cited the general fact of auroras being seen in the north and not in the south over wide stretches of lati-

tude, as one which seems to him difficult to explain on any theory that the aurora was a local phenomenon.

The meeting then adjourned.

186TH MEETING.

OCTOBER 23, 1880.

The President in the Chair.

The minutes of last meeting were read and adopted.

The President notified the meeting of the decease of General A. J. MYER, one of the members of the Society.

Dr. TONER moved the appointment of a committee to draft resolutions suitable to the occasion.

Committee appointed : Messrs. J. C. WELLING, CLEVELAND ABBE, GARRICK MALLERY.

The committee appointed at the last meeting of the Society, to report a resolution commemorative of the decease of Prof. PEIRCE, reported as follows :

Resolved, That the Philosophical Society of Washington put on record their appreciation of the eminent services to science rendered by the late Prof. Benjamin Peirce, of Harvard University, some time since Superintendent of the United States Coast Survey, and during that time a member of this Society. His introduction of the new modes of condensed mathematical thought into celestial mechanics, and his development of new algebraic methods to their uttermost limit, will ever mark him as one of the most powerful mathematicians of our age.

Mr. ALVORD said he had a warm sympathy with this just and appropriate tribute to the memory of Benjamin Peirce. Though he could say much in admiration of his genius and of his works, he would now only make an allusion to a mathematical discussion in which Prof. Peirce referred to his friend Agassiz, for whom he always expressed a warm regard.

In the spring of 1865 Prof. Peirce invited the speaker to attend the meeting, at Northampton, in August of that year, of the National Academy of Science, at which he expected to read a paper. On reaching the room was found arranged around the walls about a dozen large drawings to illustrate the "*Path of the Sling*," which was his topic. He had obtained an equation of this

path. The curve exhibiting this path was very simple in his first drawings and very complicated in the last, according to the changes made in the constants entering into the equation, but the law on the equation of the curve remained the same. The last drawings disclosed highly complex and involved curves not unlike the epicycloids.

Prof. PEIRCE said that these drawings had greatly interested Prof. Agassiz, then absent in his voyage around Cape Horn. It was a striking example of the great varieties and possibilities in nature, buried in the same law. These curves, however apparently different, were traced by the use of the same identical equation, and between the examples exhibited by Prof. Peirce of course myriads of intermediate curves existed. It is obvious that the attraction of all this to Agassiz was the analogy to organisms in botany and in zoology where groups and species obey some common generalization.

A son of Prof. Peirce has stated that this discussion was never printed, and it is feared that a large share of his brilliant original conception will never be published.

Mr. ELLIOTT referred in warm terms to the genial disposition of Prof. Pierce, and to the encouragement always given by him to young investigators, a characteristic by which he was marked.

Mr. ELLIOTT mentioned that he was the fortunate possessor of a presentation copy of the "Linear Associative Algebra" referred to by Prof. Hilgard, a work which could not fail to impress the investigator with respect and admiration for the great genius of the author.

Prof. HILGARD said he would supplement his first characterization of the ideal algebra, and would call that work the exhaustive treatment of a given mode of investigation, a method of research carried to its uttermost limit and completely exhausted.

Mr. ALVORD stated that Prof. Peirce undoubtedly did a good deal to further the cause of astronomical science by obtaining appropriations to test the value of heights on the Union Pacific Railroad for astronomical observations. In August, 1868, at Chicago, the American Association for the Advancement of Science recommended the establishment of an observatory in that region. Prof. Peirce, as Superintendent of the Coast and Geodetic Survey, had observa-

tions made at Sherman Station by Prof. C. A. Young, and on the Sierra Nevada by Prof. Davidson. All this paved the way for the endowment and establishment of the Lick Observatory. These experiments led to the conclusion that the atmosphere of California was most favorable to such observations. The more recent tentative observations of Mr. Burnham at Mount Hamilton confirm these views, and give promise of great success at the Lick Observatory.

Prof. ABBE said that while the scientific and public works of Prof. Peirce would always be spoken of with admiration, his social characteristics were equally interesting. Prof. Abbe could never forget the first time he shook hands with the venerable mathematician in 1860, when he felt that there was a bond of union and sympathy between them. Almost the first words he ever heard him utter gave a glimpse of the man himself. He had heard Prof. Peirce say that the true poet—he who writes the most elevated poetry—is the pure mathematician.

Remarks by Mr. EDWARD GOODFELLOW.

It was my privilege, more than a quarter of a century ago to be ordered to duty under Prof. Peirce's direction, to aid him in certain investigations he was making in behalf of the Coast Survey, with the object of ascertaining the most probable value to be assigned to observations of moon culminations in the determination of differences of longitude.

He was then in the prime of life and upon the threshold of that great fame which his works brought to him but a few years later. He impressed me as a man of thorough kindliness of heart. I came to Cambridge an entire stranger; he interested himself personally in obtaining for me home-like lodgings, and not unfrequently would come to my room to explain in detail, or to write out at length, formulæ which in his own very concise forms had been to me an entire puzzle.

Among the Harvard students he was very popular; his textbooks though were less liked than himself. It was a common saying among the collegians, that Prof. Peirce took for granted, in his books, that every one had as clear an insight into mathematics as he himself had.

I was on duty at West Hills, one of the Coast Survey stations on Long Island, in 1865, when Prof. Peirce came to see Mr. Bache, then just returned from Europe, but not with improved health.

Two years later, the death of Prof. Bache created a great vacancy. At that time the character and qualifications of the man who should succeed him in that high office were thoroughly understood. A recognized pre-eminence among scientific men, an ability to form an independent judgment respecting the problems of geodesy involved in the work—these were essentials. It is enough to say of Prof. Peirce that his appointment amply fulfilled these requirements. Foremost among the geometers of his own land, and regarded as in the front rank of foreign mathematicians, Prof. Peirce, during the first years of his superintendency, developed an administrative ability, which, in the methods of its exercise, won for him the friendly regard and respect of both the older and younger officers of the survey. Recognizing, with a fine tact and courtesy, the conditions entailed upon officers engaged in field work—much physical hardship, small pay, and slow promotion—he established a system of gradual increase of pay at certain intervals, and according to merit.

With Government officials, members of Congress, and all whom it was necessary to consult in obtaining appropriations for the survey, Prof. Peirce was never at fault; he knew how to use the legitimate methods of success; and he will long be remembered, not only as a great mathematician, but as the able director of an important national work.

President NEWCOMB said, as one who had known Prof. Peirce only a little less than a quarter of a century, it might not be inappropriate for him to say a few words, although much that he would have said had been anticipated by those who had already addressed the Society.

One of the most interesting points in Prof. Peirce's character was the fact that he was anything but a mathematician, as conventionally understood—cold, unsympathizing, living in an atmosphere above the rest of the world. Prof. Newcomb had never known any one who had a better heart.

Several members had spoken of the encouragement given by Prof. Peirce to those who first entered upon their life career. The speaker's first interview with that distinguished mathematician had been indelibly impressed upon his mind. What struck him most forcibly about Prof. Peirce at that time was the perfectly unsophisticated way in which he put one at ease, and the total freedom

from anything like dignity or pretentiousness which one might suppose would be seen in so great a man. An interesting trait in Prof. Peirce's intellectual character was his disposition to look at the philosophical side of things. Altogether, his mathematical works were as much treatises on formal logic as they were on formal mathematics. The paper on multiple algebra, referred to by Prof. Hilgard, had very much of that character.

Prof. Peirce's method of judging men was peculiar. Among his students he recognized only two classes—those who knew and those who did not know. Owing to the general vivacity of his character he invested the driest subjects with interest. Those who listened to his elocution almost fancied that they understood the highest things he talked about.

Mr. LESTER F. WARD made a communication on the

ANIMAL POPULATION OF THE GLOBE.

He stated that he had recently had occasion to compile, chiefly from official sources, the statistics of live stock in the various countries of the globe from which any data could be obtained, and thought that some of the general results arrived at might possess sufficient scientific interest to warrant laying them before the Society.

The whole number of countries from which information of this character had been collated was twenty-seven, embracing all the countries of Europe except European Turkey, the several British Colonies in Australasia, the Island of Ceylon, Cape Colony and Natal in South Africa, Mauritius, the Dominion of Canada, Newfoundland, Jamaica, the Argentine Republic, Uruguay, Chili, and the United States. The species of animals of which cognizance was alone taken were: horses, mules, asses, horned cattle, sheep, goats, hogs, buffaloes, and reindeer. The reports were very incomplete except with respect to the four leading species, viz: horses, cattle, sheep, and hogs.

The total number of each species actually reported upon was as follows:

Horses	-	-	-	-	-	-	47,181,384
Mules	-	-	-	-	-	-	3,474,391
Asses	-	-	-	-	-	-	2,217,166
Mules and asses, not distinguished	-						11,849

Horned cattle	-	-	-	-	157,598,521
Sheep	-	-	-	-	382,763,015
Goats	-	-	-	-	15,704,911
Hogs	-	-	-	-	81,691,331
Buffaloes	-	-	-	-	89,281
Reindeer	-	-	-	-	96,567
					<hr/>
					690,828,416

The only species for which an estimate had been made of the total number in the world was the sheep. Mr. Robert P. Porter had made such an estimate, which, though varying from the official data in many of the above countries, afforded a basis for extending the figures already obtained to the remaining portions of the globe, and according to which the ovine population of the earth would reach 577,763,015. Using this result as a basis, a very rough estimate of the number of each of the remaining species in regions not already covered by actual enumerations would place the aggregate number of all the species named throughout the world at a little upward of one billion head and their distribution would then be about as follows:

Horses	-	-	-	-	-	70,770,597
Cattle	-	-	-	-	-	236,397,781
Sheep	-	-	-	-	-	577,763,015
Hogs	-	-	-	-	-	100,000,000
All other animals	-	-	-	-	-	32,391,247
						<hr/>
						1,017,322,640

Reasons were, however, given for regarding this estimate considerably too low, both as to the number of sheep, upon which it is based, and also in the aggregate, and the speaker thought that the latter would probably reach nearly a billion and a half.

Comparisons were then made with the human population. According to a recent work by Baron Kolb the population of the 27 countries, from which reports were obtained, amounted, in 1878, to 366,100,000. This would give, upon an average, in all these countries, 130 horses, 430 cattle, 1,046 sheep, 224 hogs, and 29 of all the remaining animals taken together, to each 1,000 human beings, and for all these species combined, 1,887 animals to each 1,000 of population.

The latest issue of Behm & Wagner's *Bevölkerung der Erde*, (No. 6,) gives the present population of the earth at 1,456,000,000. If the above estimates of the number of each of these classes of animals in the entire world could be relied upon, they would show, for each 1,000 of human population, 50 horses, 166 cattle, 407 sheep, 70 hogs, and 23 of the other species taken together, or 716 of all the kinds enumerated. But, as above stated, these figures are probably far too low, and, if the truth could be known, it would probably be found that the animal population within these limits would not fall far below the human population.

The paper was concluded with some general observations on the moral bearings of the question of animal domestication. It was held that these facts constituted a sufficient justification of man's general treatment of the brute creation; that a larger amount of animal life exists under man's influence than could exist without it; that he creates more life than he destroys; that his methods of destruction are less painful than those of Nature; that it is to his interest to treat animals well, to supply them with abundant food, and relieve them from those constant fears, both of enemies and of want, which characterize their condition in a wild state; and that when life is taken, it is done quickly and as painlessly as possible; that the reverse of all this is the case in Nature, and hence a great amount of human sympathy is wasted on the creatures under man's control in consequence of ignorance of a few facts and principles.

Observations on the foregoing paper were made by Messrs. ELLIOTT and GILL.

The meeting then adjourned.

187TH MEETING. 10TH ANNUAL MEETING, NOVEMBER 6TH, 1880.

Vice-President HILGARD in the Chair.

Thirty-nine members present.

Meeting called to order by the Chair.

The Secretary read proceedings of the last annual meeting (168th meeting) held November 16th, 1879.

The names of members elected since the last annual meeting were announced.

Preliminary to voting, the list of paid up members was read.

The election of officers for the ensuing year was conducted in accordance with the rules of the Society, with the following results:—

<i>President,</i>	JOSEPH JANVIER WOODWARD.
<i>Vice-Presidents,</i>	W. B. TAYLOR, J. C. WELLING, J. E. HILGARD, J. K. BARNES,
<i>Treasurer,</i>	CLEVELAND ABBE.
<i>Secretaries,</i>	T. N. GILL, C. E. DUTTON.

MEMBERS OF THE GENERAL COMMITTEE.

JOHN W. POWELL,	SIMON NEWCOMB,
WILLIAM HARKNESS,	E. B. ELLIOTT,
GARRICK MALLERY,	CHAS. A. SHOTT,
JOHN R. EASTMAN,	THOMAS ANTISELL,
JOS. M. TONER.	

It was moved by Mr. COFFIN—

That the consideration of the subject of annual reports to be made by the officers of the Society, be referred to the General Committee, for such action as they may deem desirable.

Adopted.

It was also moved by Mr. COFFIN—

That the General Committee be requested to provide some means for obtaining an annual address from the retiring President and report the same to the Society.

Adopted.

Society then adjourned.

188TH MEETING.

NOVEMBER 20, 1880.

The President, Mr. J. J. WOODWARD, in the Chair, and 58 members present.

The newly-elected President addressed a few remarks to the Society, expressive of his high appreciation of the honor conferred upon him by his election as President of the Society, and conveying

assurance of his desire and earnest efforts to fill the office acceptably, and to aid in rendering its meetings interesting and instructive.

The Chair announced the appointment of a Committee on Communications, viz: Mr. C. E. DUTTON and Mr. GARRICK MALLERY.

Mr. J. C. WELLING then presented, pursuant to a resolution of the Society passed at its 186th meeting, the following preamble and resolution relative to the decease of an honored fellow member, viz., the late General ALBERT J. MYER :

WHEREAS in the death of Brigadier General ALBERT J. MYER, late Chief Signal Officer of the Army, this Society has been called upon to mourn the loss of one of its founders as well as one of its most distinguished members, therefore, be it

Resolved, That in testifying our deep regret at the sudden termination of the useful life of General MYER, while as yet he was apparently in the mid-career of his activity, we, at the same time, would record our admiration of those energetic qualities which he brought to every sphere of duty he was called to fill, and by virtue of which he was able, on the one hand, to organize a system of military signaling highly valuable to the Government in the late war, and, on the other hand, to develop a wide field of usefulness by directing the whole energy of the signal service to the study and the practical applications of the science of meteorology, in both which provinces he displayed a remarkable talent for control and great liberality of public spirit.

Resolved, That these proceedings be entered upon the minutes of the Society.

The first communication of the evening was by Mr. JOHN JAY KNOX, entitled

THE DISTRIBUTION OF LOANS IN THE BANK OF FRANCE, THE NATIONAL BANKS OF THE UNITED STATES, AND THE IMPERIAL BANK OF GERMANY.

Mr. KNOX first gave a brief outline of the operations of the Bank of France during and since the late Franco-Prussian war. While it appears that the bank deals in very large amounts of money, particular attention was drawn to the fact that it also distributes among the people smaller amounts than the smallest banks in this country, and, in its annual reports of its transactions, prides itself upon the fact that it has rendered services to so many of the humblest citizens. After reciting the amount of commercial paper discounted, the amount of advances on collateral securities, and

the amount of securities of the French Government held by it, he proceeded to quote from the bank reports of 1879 the classification of the Paris bills received at the bank :

Bills of 10 fr., or \$2 each, and under	-	-	7,842
Bills of 11 fr. to 50 fr. each, or \$2.20 to \$10,			392,845
Bills of 51 fr. to 100 fr. each, or \$10.20 to \$20,			623,232
Bills of above 100 fr. each, or \$20	-	-	2,878,294
Total	-	-	3,902,213

The average value of the bills thus discounted at Paris, in 1879, was 859 francs or \$171.80. At the branches of the bank, of which there are ninety, the average amount of the bills discounted was 992 francs or \$198.40. Similarly in the year 1878, this average value was, at Paris, 892 francs or \$178.40, and in the branches of the bank 992 francs or 198.40. The averages for both the bank and its branches were for 1878, 944 francs or \$188.80, and for 1879, 900 francs or \$180.00.

The bank of France receives these bills from bankers who keep accounts with it as it discounts only for its depositors. These bankers in turn discount them for small brokers who receive them for this purpose from the working classes. The bills are presented at the bank with accompanying schedules. The rate of interest is the same on small bills as on large ones, and no charge is made beyond this ordinary discount or interest. The greater part of these small bills are promissory notes and issued from small manufacturers, and also from workmen on their own account, known as makers of the *Articles de Paris*. The annual exports of such articles amount it is said to twenty-five millions of dollars, and they consist of nic-nacs, toys, dolls, cheap bronze jewelry, and similar products.

Mr. KNOX also gave a classification of the notes and bills discounted and held by the National Banks of the United States on October, 2. 1879, when the total amount of loans was \$875,013,107.

Geographical Divisions.	Number of banks.	\$100 and less.	Over \$100 and less than \$500.	\$500 and over, but less than \$1,000.	\$1,000 and over, but less than \$5,000.	\$5,000 and over, but less than \$10,000.	\$10,000 and over.	Total.	Amount.	Average.
New England States -----	547	30,167	54,965	20,444	33,621	10,082	4,590	153,869	\$240,552,893 63	\$1,563 36
Middle States -----	641	115,285	132,032	39,484	50,854	11,453	5,276	354,384	416,600,226 30	1,175 56
Southern States -----	175	15,752	24,480	7,862	8,936	1,283	416	58,729	45,890,807 95	781 40
Western States and Territories -----	685	90,141	81,563	27,590	31,812	5,381	1,800	241,287	171,969,179 22	712 72
United States -----	2,048	251,345	296,040	95,382	125,223	28,199	12,081	808,269	\$875,013,107 10	\$1,082 58

The number of pieces of paper discounted, as will be seen, was 808,269, and the average of each discount, \$1,082.59. If the average time of these bills was sixty days, and the banks held continually the same amount, the number of discounts made during the year would be nearly five millions (4,849,614), the total discounts more than five thousand millions (5,250,000,000), which would be equal to a discount of \$700 annually for each voter, or \$500 for each family in the country. The number of notes and bills of \$100 each or less at the date named was 251,345, or nearly one-third of the whole; the number of bills of less than \$500 each was 547,385, or considerably more than two-thirds of the whole; while the number of bills of less than \$1,000 each was 642,765, which is more than three-fourths of the whole number.

Among the States having the smallest average loans were the following: New York, exclusive of the cities of New York and Albany, \$499; Pennsylvania, exclusive of Philadelphia and Pittsburgh, \$566; Maryland, exclusive of Baltimore, \$505; Kansas, in which the average was \$353; Iowa, with an average of \$375; West Virginia, of \$350; Delaware, \$556; New Jersey, \$566; Minnesota, \$621; Vermont, \$645; North Carolina, \$667; Tennessee, \$651; Maine, \$740; Indiana, \$711; New Hampshire, \$815; South Carolina, \$846; Georgia, \$882.

The Imperial Bank of Germany has a capital of \$30,000,000, and is located in the city of Berlin.

The total number of bills of all kinds discounted during the year 1879 was 2,374,394, amounting to \$852,175,650; the average amount of each bill being \$358.90. The bills are classified as follows: There were 533,564 town bills, amounting to \$263,663,280—average \$494.15 each; the number of bills on places in Germany was 1,834,351, amounting to \$578,693,335, and averaging \$315.47 each; and the number of foreign bills was 6,479, in amount \$9,819,035, and averaging \$1,515.52 each. The average amount of loans and discounts for the year was \$82,073,500.

Mr. E. B. ELLIOTT inquired whether it is desirable that bills of such small amounts as those discounted by the Bank of France should be discounted in this country; if so, what plan could be suggested?

Mr. KNOX replied that the savings banks, which receive deposits from all classes and in small amounts, might make small loans.

The laws restrict their investments to the best classes of securities. If there is any class oppressed by the want of loans it is poor people. They have a little money or negotiable property laid aside, upon which they frequently want to borrow, but they find nobody willing to loan upon it. Their only resource is to go to the note shavers and curbstone brokers, who charge them an exorbitant interest. Their wants, in his opinion, could be met by the savings banks.

Mr. J. J. WOODWARD read a communication entitled

RIDDELL'S BINOCULAR MICROSCOPES.—AN HISTORICAL NOTICE, which is printed in full in the *American Monthly Microscopical Journal* for December, 1880.

[Abstract.]

Mr. WOODWARD exhibited a large binocular microscope, which he stated had been made for the late Dr. J. L. Riddell, then Professor of Chemistry in the University of Louisiana, during the winter of 1853-4 by the Grunow Brothers, of New Haven, Connecticut, and presented to the Army Medical Museum in April, 1879, by Dr. Riddell's widow.

He said that, although the proper merit of Riddell as a discoverer in this connection had been duly acknowledged by such high continental authorities as Harting and Frey, and even by some English writers, it had been strangely ignored by others, and that even so fair and usually so accurate an author as Dr. Wm. B. Carpenter had fallen into the error of asserting that "the first really satisfactory solution of the problem was that worked out by M. Nabet;" an error the more remarkable in view of the manner in which Riddell's discovery was published and discussed in England, and of the manner in which it had been used by the opticians of that country.

Mr. WOODWARD then offered evidence to show that Riddell was the first to discover and publish the optical principle on which all the really satisfactory binocular microscopes made prior to the present year depend, as well as the inventor of two efficient and still much employed methods of applying that principle; one suitable for the simple or dissecting microscope, the other for the compound microscope.

Riddell's discovery was, briefly, that the cone of rays proceeding from a single objective may be so divided by means of reflecting prisms, placed as close behind the posterior combination of the ob-

jective as possible, that orthoscopic binocular vision can be obtained both with the simple and the compound microscope. This discovery, together with an account of one method of carrying it out, and a suggestion of the feasibility of other methods, was published by Riddell in the *New Orleans Monthly Medical Register* for October, 1852, p. 4, and subsequently in the *American Journal of Science and Arts*, for January, 1853, p. 68. This article was reprinted in London, in the *Quarterly Journal of Microscopical Science* for April 1853. (Vol. I, 1853, p. 236.)

The contrivance described in this first paper was found by Riddell to give orthoscopic binocular vision when used without eye-pieces, but when ordinary eye-pieces were employed a pseudoscopic effect was obtained. This he obviated by the use of erecting eye-pieces; but, soon after his first paper was published, Riddell devised a second plan, which gave orthoscopic binocular vision with ordinary eye-pieces, and which he subsequently always used for the compound microscope, reserving his first plan for the dissecting (simple) microscope.

A brief notice, containing, however, a correct description of Riddell's second plan, was published in the *New Orleans Monthly Medical Register* for April, 1853, (p. 78,) and reprinted in London in the *Quarterly Journal of Microscopical Science*, Vol. I, 1853, (p. 304.) Subsequently, July 30, 1853, Riddell exhibited a dissecting (simple) microscope on his old plan and a compound microscope on his new plan to the American Association for the Advancement of Science, and read a paper describing those instruments, and pretty fully discussing the principles involved. This paper was published in the *Proceedings of the Association*, Vol. VII, for 1853, (p. 16,) and in the *New Orleans Medical and Surgical Journal* for November, 1853, (p. 321.) It was reprinted in London in the *Quarterly Journal of Microscopical Science* for January, 1854, Vol. II, (p. 18.)

Mr. WOODWARD then related the manner in which Riddell's discovery was discussed at the time, in England, by Messrs. Wheatstone and Wenham, and on the continent by M. M. Harting and Nachet. He showed that Nachet's modification of the compound microscope was suggested by Riddell's first instrument, and that Nachet's excellent binocular dissecting (simple) microscope is, in its optical parts, a literal copy of the binocular dissecting (simple) microscope exhibited by Riddell at the Cleveland meeting in July,

1853. This is also true of the binocular dissecting microscopes made of late years by Beck, of London, while the highly lauded erecting binocular microscope of Mr. J. W. Stephenson, F. R. M. S., (1870-72,) is, in its optical parts, a copy of the binocular compound microscope exhibited by Riddell at the Cleveland meeting. The latter instrument, as then exhibited, although optically efficient, was roughly put together by Riddell's own hands. The instrument exhibited by Mr. Woodward was ordered by Riddell of the Grunow Brothers, in August, 1853, and delivered to him by them in March following. In its optical parts it is a copy of the model exhibited at the Cleveland meeting, but some improvements were made in the mechanical details of its construction.

J. S. BILLINGS then made some remarks upon

THE SCIENTIFIC WORK CARRIED ON UNDER THE DIRECTION OF
THE NATIONAL BOARD OF HEALTH.

Prof. Ira Remsen, of the Johns Hopkins University, has made for the Board an investigation on the organic matter in the air. By the use of tubes, filled with prepared pumice stone, all the nitrogenous matter in the air to be examined, was removed, and its quantity determined by the usual tests for free and albuminoid ammonia.

Air contaminated by being drawn through water containing decaying meat does not yield more than the usual quantity of albuminoid ammonia.

Air contaminated by being drawn over comparatively dry decaying organic matter yields more than the usual quantity of albuminoid ammonia.

Air contaminated by respiration yields more than the usual quantity of albuminoid ammonia.

The simple statement of fact that a given sample of air yields an abnormally large quantity of albuminoid ammonia is not sufficient to enable us to draw a conclusion with reference to the purity of the air. We must know at what season of the year the air was collected, and whether in the city or country; in fact, we should know everything possible concerning the air, and then let the conclusion finally drawn be a resultant of all the facts. It is probable, however, from what is now known, that the determination of the amount of albuminoid ammonia yielded by air may, under many circum-

stances, furnish us with important information concerning the quality of the air, but great caution is necessary in dealing with this principle of examination.

A series of investigations upon the effects of various soils upon ordinary sewage has been carried on under the direction of Prof. Pumpelly, of the United States Geological Survey, assisted by Prof. Smythe. The preliminary experiments related to the removal of living organisms from air and fluids by passing these through filters of various kinds, and then testing their effects upon solutions containing organic matter and susceptible of fermentative or putrefactive changes. A very large number of such solutions have been prepared and preserved under various conditions, and in no case has anything like fermentation or the development of the lower organisms been observed, unless under circumstances where the lower organisms could be introduced from without, thus giving strong negative evidence against the theory of spontaneous generation. The filtration of air from such germs was found to be a comparatively easy matter. Passing it through an inch of fine sand deprived it of the power of producing fermentative changes. On the other hand, the removal of bacterioid organisms from water was much more difficult, filtration through many feet of fine sand being insufficient to effect it. The results reported by Wernich are confirmed, viz., that air passing over putrefying fluids or moist putrefying surfaces does not take up organisms therefrom, nor does it become contaminated by passing over dried bacteria films on smooth compact surfaces such as glass or iron. From woven stuffs, however, it is readily contaminated, and wherever there is dust there is danger.

The results obtained by Dr. Bigelow in attempting to destroy the vitality of dried bacteria films by means of gaseous disinfectants were then mentioned. It is found that time is an important element in the matter, and that long exposures are necessary to secure complete destruction of vitality of such organisms. This may explain the failures to disinfect the Plymouth and the Excelsior by gaseous disinfectants.

Drs. H. C. Wood and H. F. Fremont have made a number of experiments on the inoculation of diphtheria on the lower animals with negative results. The theory of Oertel that this disease is due to specific bacteria is not confirmed by their observations. They state that their results seem to indicate that the contagious material

of diphtheria is of the nature of a septic poison which is locally very irritating to the mucous membrane, and that the disease may be often a purely local affection to be treated by local remedies.

Dr. G. M. Sternberg has been repeating the experiments of Klebs and Tommasi-Crudelli on the bacillus malariae. He finds in the malarious swamps around New Orleans, organisms not distinguishable from those figured by the authors referred to, and on cultivating them in gelatin solutions obtains a similar bacillus. He has not however obtained any specific effects by injecting these organisms into the blood of animals and is unable to confirm the conclusions announced by Klebs.

Dr. Chas. Smart, U. S. A., has been engaged on water analysis, and for the last seven months on the adulterations of food. From an analysis of over six hundred samples he concludes that while there is a considerable amount of adulteration in such articles as ground coffee and spices there is not much that is dangerous to health—in the words of the last British Parliamentary Commission we are cheated but not poisoned. Poisonous colors derived from lead and antimony are found in some candies.

The educational work of the Board was then referred to, and more especially its efforts to secure a uniform and satisfactory mode of reporting mortality statistics.

At the conclusion of Mr. Billings' remarks the society adjourned.

189TH MEETING

DECEMBER 4, 1880.

The President in the chair.

Forty-eight members present.

The minutes of the last meeting were read and adopted.

The Chair announced to the Society the election and acceptance of the following new members: ALEXANDER SMYTHE CHRISTIE, WILLIAM CRAWFORD WINLOCK, and WINSLOW UPTON.

The Chair also announced the appointment of Mr. WILLIAM HARKNESS as an additional member of the Standing Committee on Communications.

The Society then listened to the address of the retiring President, Mr. SIMON NEWCOMB, on

THE RELATION OF SCIENTIFIC METHOD TO SOCIAL PROGRESS.

AMONG those subjects which are not always correctly apprehended, even by educated men, we may place that of the true significance of scientific method, and the relations of such method to practical affairs. This is especially apt to be the case in a country like our own, where the points of contact between the scientific world on the one hand, and the industrial and political world on the other, are fewer than in other civilized countries. The form which this misapprehension usually takes is that of a failure to appreciate the character of scientific method, and especially its analogy to the methods of practical life. In the judgment of the ordinary intelligent man there is a wide distinction between theoretical and practical science. The latter he considers as that science directly applicable to the building of railroads, the construction of engines, the invention of new machinery, the construction of maps, and other useful objects. The former he considers analogous to those philosophic speculations in which men have indulged in all ages without leading to any result which he considers practical. That our knowledge of nature is increased by its prosecution is a fact of which he is quite conscious, but he considers it as terminating with a mere increase of knowledge, and not as having in its method anything which a person devoted to material interests can be expected to appreciate.

This view is strengthened by the spirit with which he sees scientific investigation prosecuted. It is well understood on all sides that when such investigations are pursued in a spirit really recognized as scientific, no merely utilitarian object is had in view. Indeed it is easy to see how the very fact of pursuing such an object would detract from that thoroughness of examination which is the first condition of a real advance. True science demands in its every research a completeness far beyond what is apparently necessary for its practical applications. The precision with which the astronomer seeks to measure the heavens, and the chemist to determine the relations of the ultimate molecules of matter has no limit, except that set by the imperfections of the instruments of

research. There is no such division recognized as that of useful and useless knowledge. The ultimate aim is nothing less than that of bringing all the phenomena of nature under laws as exact as those which govern the planetary motions.

Now the pursuit of any high object in this spirit commands from men of wide views that respect which is felt towards all exertion having in view more elevated objects than the pursuit of gain. Accordingly it is very natural to classify scientists, and philosophers with the men who in all ages have sought after learning instead of utility. But there is another aspect of the question which will show the relations of scientific advance to the practical affairs of life in a different light. I make bold to say that the greatest want of the day, from a purely practical point of view, is the more general introduction of the scientific method and the scientific spirit into the discussion of those political and social problems which we encounter on our road to a higher plane of public well being. Far from using methods too refined for practical purposes, what most distinguishes scientific from other thought is the introduction of the methods of practical life into the discussion of abstract general problems. A single instance will illustrate the lesson I wish to enforce.

The question of the tariff is, from a practical point of view, one of the most important with which our legislators will have to deal during the next few years. The widest diversity of opinion exists as to the best policy to be pursued in collecting a revenue from imports. Opposing interests contend against each other without any common basis of fact or principle on which a conclusion can be reached. The opinions of intelligent men differ almost as widely as those of the men who are immediately interested. But all will admit that public action in this direction should be dictated by one guiding principle—that the greatest good of the community is to be sought after. That policy is the best which will most promote this good. Nor is there any serious difference of opinion as to the nature of the good to be had in view; it is in a word the increase of the national wealth and prosperity. The question on which opinions fundamentally differ is that of the effects of a higher or lower rate of duty upon the interests of the public. If it were possible to foresee, with an approach to certainty, what effect a given tariff would have upon the producers and consumers of an article taxed, and, indirectly, upon each member of the community in any

way interested in the article, we should then have an exact datum which we do not now possess for reaching a conclusion. If some superhuman authority, speaking with the voice of infallibility, could give us this information, it is evident that a great national want would be supplied. No question in practical life is more important than this: How can this desirable knowledge of the economic effects of a tariff be obtained?

The answer to this question is clear and simple. The subject must be studied in the same spirit, and, to a certain extent, by the same methods which have been so successful in advancing our knowledge of nature. Every one knows that, within the last two centuries, a method of studying the course of nature has been introduced which has been so successful in enabling us to trace the sequence of cause and effect as almost to revolutionize society. The very fact that scientific method has been so successful here leads to the belief that it might be equally successful in other departments of inquiry.

The same remarks will apply to the questions connected with banking and currency; the standard of value; and, indeed, all subjects which have a financial bearing. On every such question we see wide differences of opinion without any common basis to rest upon.

It may be said, in reply, that in these cases there are really no grounds for forming an opinion, and that the contests which arise over them are merely those between conflicting interests. But this claim is not at all consonant with the form which we see the discussion assume. Nearly every one has a decided opinion on these several subjects; whereas, if there were no data for forming an opinion, it would be unreasonable to maintain any whatever. Indeed, it is evident that there must be truth somewhere, and the only question that can be open is that of the mode of discovering it. No man imbued with a scientific spirit can claim that such truth is beyond the power of the human intellect. He may doubt his own ability to grasp it, but cannot doubt that by pursuing the proper method and adopting the best means the problem can be solved. It is, in fact, difficult to show why some exact results could not be as certainly reached in economic questions as in those of physical science. It is true that if we pursue the inquiry far enough we shall find more complex conditions to encounter, because the future course of demand and supply enters as an uncertain

element. But a remarkable fact to be considered is that the difference of opinion to which we allude does not depend upon different estimates of the future, but upon different views of the most elementary and general principles of the subject. It is as if men were not agreed whether air were elastic or whether the earth turns on its axis. Why is it that while in all subjects of physical science we find a general agreement through a wide range of subjects, and doubt commences only where certainty is not attained, yet when we turn to economic subjects we do not find the beginning of an agreement?

No two answers can be given. It is because the two classes of subjects are investigated by different instruments and in a different spirit. The physicist has an exact nomenclature; uses methods of research well adapted to the objects he has in view; pursues his investigations without being attacked by those who wish for different results; and, above all, pursues them only for the purpose of discovering the truth. In economical questions the case is entirely different. Only in rare cases are they studied without at least the suspicion that the student has a preconceived theory to support. If results are attained which oppose any powerful interest, this interest can hire a competing investigator to bring out a different result. So far as the public can see, one man's result is as good as another's, and thus the object is as far off as ever. We may be sure that until there is an intelligent and rational public, able to distinguish between the speculations of the charlatan and the researches of the investigator, the present state of things will continue. What we want is so wide a diffusion of scientific ideas that there shall be a class of men engaged in studying economical problems for their own sake, and an intelligent public able to judge what they are doing. There must be an improvement in the objects at which they aim in education, and it is now worth while to inquire what that improvement is.

It is not mere instruction in any branch of technical science that is wanted. No knowledge of chemistry, physics, or biology, however extensive, can give the learner much aid in forming a correct opinion of such a question as that of the currency. If we should claim that political economy ought to be more extensively studied, we would be met by the question, which of several conflicting systems shall we teach? What is wanted is not to teach this system or that, but to give such a training that the student shall be able to decide for himself which system is right.

It seems to me that the true educational want is ignored both by those who advocate a classical and those who advocate a scientific education. What is really wanted is to train the intellectual powers, and the question ought to be, what is the best method of doing this? Perhaps it might be found that both of the conflicting methods could be improved upon. The really distinctive features, which we should desire to see introduced, are two in number: the one the scientific spirit; the other the scientific discipline. Although many details may be classified under each of these heads, yet there is one of pre-eminent importance on which we should insist.

The one feature of the scientific spirit which outweighs all others in importance is the love of knowledge for its own sake. If by our system of education we can inculcate this sentiment we shall do what is, from a public point of view, worth more than any amount of technical knowledge, because we shall lay the foundation of all knowledge. So long as men study only what they think is going to be useful their knowledge will be partial and insufficient. I think it is to the constant inculcation of this fact by experience, rather than to any reasoning, that is due the continued appreciation of a liberal education. Every business man knows that a business-college training is of very little account in enabling one to fight the battle of life, and that college bred men have a great advantage even in fields where mere education is a secondary matter. We are accustomed to seeing ridicule thrown upon the questions sometimes asked of candidates for the civil service because the questions refer to subjects of which a knowledge is not essential. The reply to all criticisms of this kind is that there is no one quality which more certainly assures a man's usefulness to society than the propensity to acquire useless knowledge. Most of our citizens take a wide interest in public affairs, else our form of government would be a failure. But it is desirable that their study of public measures should be more critical and take a wider range. It is especially desirable that the conclusions to which they are led should be unaffected by partisan sympathies. The more strongly the love of mere truth is inculcated in their nature the better this end will be attained.

The scientific discipline to which I ask mainly to call your attention consists in training the scholar to the scientific use of language. Although whole volumes may be written on the logic of science

there is one general feature of its method which is of fundamental significance. It is that every term which it uses and every proposition which it enunciates has a precise meaning which can be made evident by proper definitions. This general principle of scientific language is much more easily inculcated by example than subject to exact description ; but I shall ask leave to add one to several attempts I have made to define it. If I should say that when a statement is made in the language of science the speaker knows what he means, and the hearer either knows it or can be made to know it by proper definitions, and that this community of understanding is frequently not reached in other departments of thought, I might be understood as casting a slur on whole departments of inquiry. Without intending any such slur, I may still say that language and statements are worthy of the name scientific as they approach this standard ; and, moreover, that a great deal is said and written which does not fulfill the requirement. The fact that words lose their meaning when removed from the connections in which that meaning has been acquired and put to higher uses, is one which, I think, is rarely recognized. There is nothing in the history of philosophical inquiry more curious than the frequency of interminable disputes on subjects where no agreement can be reached because the opposing parties do not use words in the same sense. That the history of science is not free from this reproach is shown by the fact of the long dispute whether the force of a moving body was proportional to the simple velocity or to its square. Neither of the parties to the dispute thought it worth while to define what they meant by the word "force," and it was at length found that if a definition was agreed upon the seeming difference of opinion would vanish. Perhaps the most striking feature of the case, and one peculiar to a scientific dispute, was that the opposing parties did not differ in their solution of a single mechanical problem. I say this is curious, because the very fact of their agreeing upon every concrete question which could have been presented, ought to have made it clear that some fallacy was lacking in the discussion as to the measure of force. The good effect of a scientific spirit is shown by the fact that this discussion is almost unique in the history of science during the past two centuries, and that scientific men themselves were able to see the fallacy involved, and thus to bring the matter to a conclusion.

If we now turn to the discussions of philosophers, we shall find at

least one yet more striking example of the same kind. The question of the freedom of the human will has, I believe, raged for centuries. It cannot yet be said that any conclusion has been reached. Indeed I have heard it admitted by men of high intellectual attainments that the question was insoluble. Now a curious feature of this dispute is that none of the combatants, at least on the affirmative side, have made any serious attempt to define what should be meant by the phrase freedom of the will, except by using such terms as require definition equally with the word freedom itself. It can, I conceive, be made quite clear that the assertion, "The will is free," is one without meaning, until we analyze more fully the different meanings to be attached to the word free. Now this word has a perfectly well-defined signification in every day life. We say that anything is free when it is not subject to external constraint. We also know exactly what we mean when we say that a man is free to do a certain act. We mean that if he chooses to do it there is no external constraint acting to prevent him. In all cases a relation of two things is implied in the word, some active agent or power, and the presence or absence of another constraining agent. Now, when we inquire whether the will itself is free, irrespective of external constraints, the word free no longer has a meaning, because one of the elements implied in it is ignored.

To inquire whether the will itself is free is like inquiring whether fire itself is consumed by the burning, or whether clothing is itself clad. It is not, therefore, at all surprising that both parties have been able to dispute without end, but it is a most astonishing phenomenon of the human intellect that the dispute should go on generation after generation without the parties finding out whether there was really any difference of opinion between them on the subject. I venture to say that if there is any such difference, neither party has ever analyzed the meaning of the words used sufficiently far to show it. The daily experience of every man, from his cradle to his grave, shows that human acts are as much the subject of external causal influences as are the phenomena of nature. To dispute this would be little short of the ludicrous. All that the opponents of freedom, as a class, have ever claimed, is the assertion of a causal connection between the acts of the will, and influences independent of the will. True, propositions of this sort can be expressed in a variety of ways connoting an endless number of more or less objectionable ideas, but this is the substance of the matter.

To suppose that the advocates on the other side meant to take issue on this proposition would be to assume that they did not know what they were saying. The conclusion forced upon us is that though men spend their whole lives in the study of the most elevated department of human thought it does not guard them against the danger of using words without meaning. It would be a mark of ignorance, rather than of penetration, to hastily denounce propositions on subjects we are not well acquainted with because we do not understand their meaning. I do not mean to intimate that philosophy itself is subject to this reproach. When we see a philosophical proposition, couched in terms we do not understand, the most modest and charitable view is to assume that this arises from our lack of knowledge. Nothing is easier than for the ignorant to ridicule the propositions of the learned. And yet, with every reserve, I cannot but feel that the disputes to which I have alluded prove the necessity of bringing scientific precision of language into every demand of thought. If the discussion had been confined to a few, and other philosophers had analyzed the subject, and showed the fictitious character of the discussion, or had pointed out where opinions really might differ, there would be nothing derogatory to philosophers. But the most suggestive circumstance is that although a large proportion of the philosophic writers in recent times have devoted more or less attention to the subject, few, or none, have made even this modest contribution. I speak with some little confidence on this subject, because several years ago I wrote to one of the most acute thinkers of the country, asking if he could find in philosophical literature any terms or definitions expressive of the three different senses in which not only the word freedom, but nearly all words implying freedom were used. His search was in vain.

Nothing of this sort occurs in the practical affairs of life. All terms used in business, however general or abstract, have that well-defined meaning which is the first requisite of the scientific language. Now one important lesson which I wish to inculcate is that the language of science in this respect corresponds to that of business; in that each and every term that is employed has a meaning as well defined as the subject of discussion can admit of. It will be an instructive exercise to inquire what this peculiarity of scientific and business language is. It can be shown that a certain requirement should be fulfilled by all language intended for the discovery of truth, which is fulfilled only by the two classes of

language which I have described. It is one of the most common errors of discourse to assume that any common expression which we may use always conveys an idea, no matter what the subject of discourse. The true state of the case can, perhaps, best be seen by beginning at the foundation of things, and examining under what conditions language can really convey ideas.

Suppose thrown among us a person of well-developed intellect, but unacquainted with a single language or word that we use. It is absolutely useless to talk to him, because nothing that we say conveys any meaning to his mind. We can supply him no dictionary, because by hypothesis he knows no language to which we have access. How shall we proceed to communicate our ideas to him? Clearly there is but one possible way, namely, through his five senses. Outside of this means of bringing him in contact with us we can have no communication with him. We, therefore, begin by showing him sensible objects, and letting him understand that certain words which we use correspond to those objects. After he has thus acquired a small vocabulary, we make him understand that other terms refer to relations between objects which he can perceive by his senses. Next he learns, by induction, that there are terms which apply not to special objects, but to whole classes of objects. Continuing the same process, he learns that there are certain attributes of objects made known by the manner in which they affect his senses, to which abstract terms are applied. Having learned all this, we can teach him new words by combining words without exhibiting objects already known. Using these words we can proceed yet further, building up, as it were, a complete language. But there is one limit at every step. Every term which we make known to him must depend ultimately upon terms the meaning of which he has learned from their connection with special objects of sense.

To communicate to him a knowledge of words expressive of mental states it is necessary to assume that his own mind is subject to these states as well as our own, and that we can in some way indicate them by our acts. That the former hypothesis is sufficiently well established can be made evident so long as a consistency of different words and ideas is maintained. If no such consistency of meaning on his part were evident, it might indicate that the operations of his mind were so different from ours that no such communication of ideas was possible. Uncertainty in this respect must

arise as soon as we go beyond those mental states which communicate themselves to the senses of others.

We now see that in order to communicate to our foreigner a knowledge of language, we must follow rules similar to those necessary for the stability of a building. The foundation of the building must be well laid upon objects knowable by his five senses. Of course the mind, as well as the external object, may be a factor in determining the ideas which the words are intended to express; but this does not in any manner invalidate the conditions which we impose. Whatever theory we may adopt of the relative part played by the knowing subject, and the external object in the acquirement of knowledge, it remains none the less true that no knowledge of the meaning of a word can be acquired except through the senses, and that the meaning is, therefore, limited by the senses. If we transgress the rule of founding each meaning upon meanings below it, and having the whole ultimately resting upon a sensuous foundation, we at once branch off into sound without sense. We may teach him the use of an extended vocabulary, to the terms of which he may apply ideas of his own, more or less vague, but there will be no way of deciding that he attaches the same meaning to these terms that we do.

What we have shown true of an intelligent foreigner is necessarily true of the growing man. We come into the world without a knowledge of the meaning of words, and can acquire such knowledge only by a process which we have found applicable to the intelligent foreigner. But to confine ourselves within these limits in the use of language requires a course of severe mental discipline. The transgression of the rule will naturally seem to the undisciplined mind a mark of intellectual vigor rather than the reverse. In our system of education every temptation is held out to the learner to transgress the rule by the fluent use of language to which it is doubtful if he himself attaches clear notions, and which he can never be certain suggests to his hearer the ideas which he intends. Indeed, we not infrequently see, even among practical educators, expressions of positive antipathy to scientific precision of language so obviously opposed to good sense that they can be attributed only to a failure to comprehend the meaning of the language which they criticise.

Perhaps the most injurious effect in this direction arises from the natural tendency of the mind, when not subject to a scientific

discipline, to think of words expressing sensible objects and their relations as connoting certain supersensuous attributes. This is frequently seen in the repugnance of the metaphysical mind to receive a scientific statement about a matter of fact simply as a matter of fact. This repugnance does not generally arise in respect to the every day matters of life. When we say that the earth is round we state a truth which every one is willing to receive as final. If without denying that the earth was round, one should criticise the statement on the ground that it was not necessarily round but might be of some other form, we should simply smile at this use of language. But when we take a more general statement and assert that the laws of nature are inexorable, and that all phenomena, so far as we can show, occur in obedience to their requirements, we are met with a sort of criticism with which all of us are familiar, and which I am unable adequately to describe. No one denies that as a matter of fact, and as far as his experience extends, these laws do appear to be inexorable. I have never heard of any one professing, during the present generation, to describe a natural phenomenon, with the avowed belief that it was not a product of natural law; yet we constantly hear the scientific view criticised on the ground that events may occur without being subject to natural law. The word "may," in this connection, is one to which we can attach no meaning expressive of a sensuous relation.

This is, however, not the most frequent misuse of the word may. In fact, the unscientific use of language to which I refer, is most strongly shown in disquisitions on the freedom of the will. When I say that it is perfectly certain that I will to-morrow perform a certain act unless some cause external to my mind which I do not now foresee occurs to prevent me, I make a statement which is final so far as scientific ideas are concerned. But it will sometimes be maintained that however certain it may be that I shall perform this act, nevertheless I may act otherwise. All I can say to this is that I do not understand the meaning of the statement.

The analogous conflict between the scientific use of language and the use made by some philosophers, is found in connection with the idea of causation. Fundamentally the word cause is used in scientific language in the same sense as in the language of common life. When we discuss with our neighbors the cause of a fit of illness, of a fire, or of cold weather, not the slightest ambiguity attaches to the use of the word, because whatever meaning may

be given to it is founded only on an accurate analysis of the ideas involved in it from daily use. No philosopher objects to the common meaning of the word, yet we frequently find men of eminence in the intellectual world who will not tolerate the scientific man in using the word in this way. In every explanation which he can give to its use they detect ambiguity. They insist that in any proper use of the term the idea of power must be connoted. But what meaning is here attached to the word power, and how shall we first reduce it to a sensible form, and then apply its meaning to the operations of nature? That this can be done, I by no means deny. All I maintain is that if we shall do it, we must pass without the domain of scientific statement.

Perhaps the greatest advantage in the use of symbolic and other mathematical language in scientific investigation is that it cannot possibly be made to connote anything except what the speaker means. It adheres to the subject matter of discourse with a tenacity which no criticism can overcome. In consequence, whenever a science is reduced to a mathematical form its conclusions are no longer the subject of philosophical attack. To secure the same desirable quality in all other scientific language it is necessary to give it, so far as possible, the same simplicity of signification which attaches to mathematical symbols. This is not easy, because we are obliged to use words of ordinary language, and it is impossible to divest them of whatever they may connote to ordinary hearers.

I have thus sought to make it clear that the language of science corresponds to that of ordinary life, and especially of business life, in confining its meaning to phenomena. An analogous statement may be made of the method and objects of scientific investigation. I think Professor Clifford was very happy in defining science as organized common sense. The foundation of its widest general creations is laid, not in any artificial theories, but in the natural beliefs and tendencies of the human mind. Its position against those who deny these generalizations is quite analogous to that taken by the Scottish school of philosophy against the skepticism of Hume.

It may be asked, if the methods and language of science correspond to those of practical life,—why is not the every day discipline of that life as good as the discipline of science? The answer is, that the power of transferring the modes of thought of common life to subjects of a higher order of generality is a rare faculty

which can be acquired only by scientific discipline. What we want is that in public affairs men shall reason about questions of finance, trade, national wealth, legislation and administration with the same consciousness of the practical side that they reason about their own interests. When this habit is once acquired and appreciated, the scientific method will naturally be applied to the study of questions of social policy. When a scientific interest is taken in such questions, their boundaries will be extended beyond the utilities immediately involved, and then the last condition of unceasing progress will be complied with.

At the conclusion of Mr. Newcomb's address it was moved by Mr. Hilgard that the thanks of the Society are due to Mr. Newcomb for his weighty, instructive, and interesting address.

The motion was carried.

Mr. J. E. HILGARD then made a communication on the subject of

A MODEL OF THE BASIN OF THE GULF OF MEXICO.

He exhibited to the Society a model of the Gulf of Mexico recently constructed under the direction of the Coast Survey Office upon data obtained by a very great number of soundings. Of these many thousands have been made, and the model is believed to be very correct. As constructed, the vertical scale is thirty times as great as the horizontal in order to emphasize and render easily intelligible the most notable features.

The soundings of the waters in the Gulf of Mexico began with the extension thither of the work of the Coast Survey, but they were at first only littoral and tributary to the topographic and hydrographic work of the Bureau. They were interrupted by the civil war, but were resumed at its close. Soundings had also been made off the east coast of Florida to ascertain the nature and dimensions of the outlet of the Gulf stream. This outlet was found to be relatively quite small. Soundings and temperatures had been taken from Florida to Cuba and to Yucatan. Within a few years the work of exploring the general configuration of the Gulf of Mexico has been commenced by Commander Sigsbee, of the Navy, on duty in the Coast and Geodetic Survey. This officer made great improvements in deep-sea sounding apparatus, and, prosecuting the

exploration with great energy and ingenuity, has brought the work to a speedy conclusion.

As a result of these investigations, it is found that the continental profiles which descend from every direction beneath the water of the gulf, have, at first, a very gradual slope of a few feet to the mile—until the 100 fathom depth, or thereabout, is reached. They then descend much more rapidly, and, in some places, with singular abruptness to depths exceeding 2,000 fathoms. All around the gulf shores is a marginal belt of varying width and of comparatively shallow water. Within this marginal belt is an area of similar shape to that of the gulf itself, and nearly concentric with its coast, where the depth is comparable to that of mid-ocean. The extent of the deeper area is about 50,000 square miles. It also appears that the continental or peninsular mass of Florida is of much greater area than that portion which exposes its surface above the water, and the same is true of Yucatan. An examination of the portions in the vicinity of the Mississippi river, shows that the delta has very nearly reached the position where the profile begins to drop rapidly down into deep water, and the apprehensions of those who fear that the jetties lately constructed may cause the accumulation of deposits further out may therefore be dispelled or greatly mitigated.

Turning to the channel of the Gulf stream, Mr. Hilgard remarked that its transverse section between Florida and the Bahama Banks, did not exceed twelve square miles. With an average current velocity of only $2\frac{1}{2}$ miles per hour, it appears quite incredible that enough water can be discharged through this passage to occasion the mild climate of western Europe. The main mass of the great oceanic drift which warms these shores, he thought must be derived from the Caribbean Sea, passing out between the greater Antilles, where the passes are far wider and deeper. Of this greater oceanic drift the efflux through the Florida straits forms but a small part.

Remarks upon this communication were made by Messrs. ALVORD, DUTTON, GILL, HARKNESS and WHITE.

The Society then adjourned.

190TH MEETING.

DECEMBER 18, 1880.

The President in the Chair.

Forty-two members present.

The minutes of the last meeting were read and adopted.

A communication was then read by Mr. SWAN M. BURNETT, entitled

COLOR PERCEPTION AND COLOR BLINDNESS.

The speaker first gave the Young-Helmholtz theory, which consists in the assumption of three fibres in the retina corresponding to the so-called fundamental colors, red, green and violet, stating the objections that have been brought against this theory by Mauthner and others, when viewed from the standpoint of color blindness.

He then explained in brief the theory of Prof. Hering, of Prague, according to which there are supposed to be in the retina three chemical substances, which are called the *black-white*, the *red-green*, and the *blue-yellow*. These are acted on by light, by assimilation, and by dissimulation. Dissimulation (D) of the black-white substance produces white, its assimilation (A) black. The D-action on the red-green produces red, the A-action green. The D-action on the blue-yellow substance produces blue, the A-action yellow. When one of the substances is lacking there is an inability to properly perceive the pair of colors peculiar to it. There is therefore red-green blindness, and blue-yellow blindness. The objections to this theory as advanced by Prof. Donders and others were then brought forward.

There are two strong objections to both these theories aside from those mentioned, first, their want of simplicity, and second, the necessity of inventing new tissues and novel reactions of tissues to the affecting agent.

The true theory of colors, when found, we have every right to expect will be simple, and the laws governing it will be in keeping with the action of light on simple substances, and in the opinion of the speaker, they would be found to lie in the direction of the recent discoveries of the action of light on the molecular structure of homogeneous substances, and he accepted as the foundation of his speculations that *variation in sensation would have its basis, not in complexity of tissue, but in the varying action of the affecting agent.*

A theory on this basis would have the retina a substance whose molecular structure would be such as to allow it to respond promptly to each of those undulations of the ether corresponding to the principal colors. The wave length corresponding to red, for example, would produce a molecular change (most probably simply vibratory) which would be carried to the brain centre of vision by the optic nerve,

and there transformed into a distinct sensation. The same would hold good probably for the orange, yellow, green, blue and violet. We have an analogy for such reaction in the molecular change produced by light in the metal selenium when in a crystallized state, and in some other substances. The photophone depends for its existence upon this delicate reaction of the molecular structure of selenium to the influence of light. Which are the primary and which the secondary colors—that is those arising from mixed sensations—would have to be determined by experiment.

The speaker would divide color blindness into two classes, *peripheral* and *central*. In the former the retina and optic nerve would be the agents affected, in the latter the cerebral centre of vision. The latter he considered to be the most common form of congenital color blindness, and it was due in his opinion to the fact that this centre had not yet developed the power of properly differentiating the closely allied impressions sent to it. In such cases, the spectrum was not shortened, but was seen dichromic, the line of demarcation being usually at the blue.

As regards the *retinal* form one broad general principle might be laid down, that where there was a lacking color the molecular changes in the retina were such as to incapacitate it from responding promptly to the wave lengths which physically represent that color.

Believing that education had much to do with the development of the color-sense, the speaker had devised a plan for the "systematic education of the color-sense in children," which, if followed out closely, would, he believed, in the course of generations, make color-blindness as rare in the male sex as it now is among females. This plan is published in full in the Archives of Ophthalmology. (G. P. Putnam's Sons, New York, October, 1879.)

The next communication was by Mr. E. M. GALLAUDET, entitled—

THE INTERNATIONAL CONVENTION OF THE TEACHERS OF THE
DEAF AND DUMB, AT MILAN.

Mr. GALLAUDET recited first certain resolutions adopted at that convention, which were as follows :

"The convention, considering the incontestable superiority of speech over signs, 1st, for restoring deaf-mutes to social life, 2d, for giving them greater facility of language, declares that the

method of articulation should have the preference over that of signs in the instruction and education of the deaf and dumb.

"Considering that the simultaneous use of signs and speech has the disadvantage of injuring speech and lip reading and precision of ideas, the convention declares that the pure oral method ought to be preferred."

Apropos to these resolutions, Mr. GALLAUDET quoted the comments of the London *Times*, which journal remarks that—

"No more representative body could have been collected than that which at Milan has declared for oral teaching for the deaf and dumb, and for nothing but oral teaching," and also speaks of the action of the convention as expressing a "virtual unanimity of preference for oral teaching, which might seem to overbear all possibility of opposition."

Mr. GALLAUDET then proceeded to explain the composition of the convention, which, he stated, consisted of 164 members, of whom eighty-seven were Italians and fifty-six French, these two nationalities composing seven-eighths of its representation. There were from America five members, while the city of Milan alone furnished forty-six. The president and secretary, both oralists, were from Milan, and seven out of eight other officers were also oralists. The Paris convention, in 1878, had been organized by the Pereire Society, an active propaganda in favor of the exclusive oral method; and the organization of the Milan convention was of a similar nature, and cannot be regarded as representative of the general body of instructors of the deaf and dumb throughout the world, as the preceding statement of its composition must indicate. The American delegates voted in favor of the combined method of teaching, both orally and by signs.

He expressed, in closing, the conviction that teachers of this country are working in the right direction, and that, in due time, the relative importance as well as the proper sphere of the two methods will be fully recognized in the combined system.

191ST MEETING.

JANUARY 8, 1881.

Vice-President TAYLOR in the Chair.

Twenty-seven members present.

The minutes of the last meeting were read and adopted.

A communication by Mr. W. F. McK. RITTER was then read, entitled—

ON A SIMPLE METHOD OF DERIVING SOME EQUATIONS USED IN
THE THEORY OF THE MOON AND OF THE PLANETS.

The rectangular and polar co-ordinates of a heavenly body are functions of the elements of the orbit and of the time. When the elements are pure constants, as in the case of undisturbed motion, these co-ordinates vary only with the time; but when the effect of the disturbing force is considered, we have variation or perturbation of the elements, and hence, also, the co-ordinates vary both with the time and the elements.

Since the co-ordinates are functions of the elements, as long as the variations of the elements are unknown, the corresponding corrections to the co-ordinates, due to these variations, must be regarded as zero. Hence, in the differentiation, the differentials of the co-ordinates with respect to the elements, alone considered as variable, must be put equal to zero. Hence, also, the velocities of the rectangular and polar co-ordinates are zero, and thus we are furnished with equations of condition, which greatly facilitate the solution of the problem of determining the perturbations of the elements.

In finding what are called the special perturbations, we resolve the disturbing force into three components.

For this purpose, call

R, the component in the direction of the radius-vector,

S, the component perpendicular to the radius-vector, parallel to the plane of the orbit, and positive in the direction of the motion, and

Z, the component perpendicular to the plane of the orbit.

The values of these components, in the form we wish to employ, are

$$R = k^2 (1 + m) \frac{d\Omega}{dr},$$

$$S = k^2 (1 + m) \frac{1}{r} \frac{d\Omega}{dv},$$

$$Z = k^2 (1 + m) \frac{d\Omega}{dz}.$$

Here Ω is the disturbing function, r and v are polar co-ordinates, z the co-ordinate perpendicular to the plane of the orbit, k^2 the

Gaussian constant, and m the relation of the mass of the disturbed body to that of the sun.

By putting the first differential co-efficients of the co-ordinates with respect to the time equal to zero, we derive, with great ease, the expressions for the variations of the elements. This is for the case of special perturbations. These expressions will contain the components R , S , and Z .

If we now substitute the values of these components, wherever they appear, and perform the necessary reductions, we get expressions for the variations of the elements, where, instead of the components of the disturbing force, the force itself appears.

In the case of the mean anomaly, another method has been followed. Its variation can best be found by means of the relation

$$M = \mu (t - T),$$

where M represents the mean anomaly, μ the mean daily motion, and T the time of perihelion-passage.

I have thus derived, among others, the equations :

$$\begin{aligned}\frac{dL}{dt} &= k^2 (1+m) \frac{d\Omega}{dM}, & \frac{dM}{dt} &= -k^2 (1+m) \frac{d\Omega}{dL} \\ \frac{dG}{dt} &= k^2 (1+m) \frac{d\Omega}{d\omega}, & \frac{d\omega}{dt} &= -k^2 (1+m) \frac{d\Omega}{dG}, \\ \frac{dH}{dt} &= k^2 (1+m) \frac{d\Omega}{d\Omega}, & \frac{d\Omega}{dt} &= -k^2 (1+m) \frac{d\Omega}{dH}.\end{aligned}$$

From these, by slight changes, we get the equations used by Delaunay in his theory of the moon's motion. Thus by putting $k^2 (1+m) \Omega = R$, and writing l, g, h , for M, ω, Ω , respectively, we have

$$\begin{aligned}\frac{dL}{dt} &= \frac{dR}{dl}, & \frac{dl}{dt} &= -\frac{dR}{dL}, \\ \frac{dG}{dt} &= \frac{dR}{dg}, & \frac{dg}{dt} &= -\frac{dR}{dG}, \\ \frac{dH}{dt} &= \frac{dR}{dh}, & \frac{dh}{dt} &= -\frac{dR}{dH}.\end{aligned}$$

In these equations, according to the notation of Delaunay, $L = \sqrt{a\mu}$, μ being the sum of the masses of the earth and moon, $G = L\sqrt{1-e^2}$, $H = G \cos i$; a, e , and i being the semi-major axis, eccentricity, and inclination respectively; l designates the mean anomaly, g the angular distance of the ascending node from the perigee, and h the longitude of the ascending node.

The equations which Le Verrier uses in his theories of the planets are not as simple in form as those of Delaunay; but there is no difficulty attending their derivation by this method. The method Le Verrier uses in deriving them is long and cumbrous. Delaunay does not stop to derive the equations he uses, but refers, on this head, to a memoir by Benét.

By the method given above I have derived all the fundamental equations used by these authors, and by those who have considered the subject of perturbations from the same standpoint.

I think I have here given enough of the process to enable any one to understand the method. I may add that the method occurred to me seven or eight years ago.

The next communication was by Mr. EDGAR FRISBY

ON THE ORBIT OF SWIFT'S COMET.

This comet was first observed by Prof. Swift of Rochester, October 10, 1880, and was reported by him as moving directly towards the earth. It was observed by Prof. Eastman with the transit circle of the U. S. Naval Observatory on the evenings of October 25, November 7, and November 20, and from the data so obtained the following elements were computed by Prof. Frisby :

Epoch of perihelion passage 7^a.775675 Washington mean time

$$\left. \begin{array}{l} \Omega = 296^{\circ} 48' 19.''9 \\ \pi = 42^{\circ} 59' 15.''8 \\ \vartheta = 42^{\circ} 26' 48.''5 \\ \iota = 5^{\circ} 30' 35.''9 \\ \log a = 0.517002 \\ \log \mu = 2.774504 \end{array} \right\} \text{Mean Equinox 1880.0.}$$

From these elements it will be inferred that it was moving very nearly towards the earth at the time of discovery, October 10. On November 8, it came very near the earth's orbit, its distance from it then being about 0.069 of the earth's mean distance from the sun. The aphelion lies just beyond Jupiter's orbit so that its perturbations are liable at any time to become immense. The periodic time from the elements is about 2,178 days, or a little less than six years, but Jupiter's position in his orbit is now such that it is not likely to come near the comet for a long period. For a time after the discovery of the comet it was doubtful whether the period was 11 or 5½ years. The latter is undoubtedly the true one, the slight

discrepancy being due to insufficient data. It would probably be impossible to see it at every return, for assuming its period to be approximately $5\frac{1}{2}$ years, the earth would at each alternate return be at the opposite side of its orbit, and the sun would then intervene between the earth and the comet. It passed nearest to the earth about the 18th of November.

The logarithms of the radii vectors and distance from the earth on the dates given are :

	log. r	log. Δ
October 25,	0.035328	9.221510
November 7,	0.029018	9.141693
November 20,	0.034557	9.119295

No theory about any periodic time was assumed in these calculations.

At the conclusion of Mr. Frisby's paper the Society adjourned.

192D MEETING.

JANUARY 22, 1881.

The President in the Chair.

Thirty-seven members present.

The following communication was read by Mr. J. W. CHICKERING, entitled—

NOTES ON ROAN MOUNTAIN, NORTH CAROLINA.

The great Appalachian chain, with its undulating line of 1,300 miles, from the promontory of Gaspè, on the Gulf of St. Lawrence, to Georgia and Alabama, beginning as a series of simple folds of moderate height, increases in complexity as in altitude from north to south, attaining its greatest elevation in a veritable mountain knot in the Black range. Following it from its commencement to the Hudson, we find the single chain of the Green Mountains, rising to its extreme height in Mount Mansfield, 4,430 feet, with, on the east, the outlying clusters of the White Mountains in New Hampshire, with Mount Washington reaching 6,288 feet, and others exceeding 5,000 feet, and Mount Katahdin in Maine, 100 miles away, about 5,200 feet, and on the west the Adirondack group, rising to 5,379 feet, and the Catskills considerably lower.

From the Hudson to the New River in Virginia, 450 miles, through the States of New Jersey, Pennsylvania, and Virginia, it

gradually gains in both width and altitude, consisting of many parallel ranges, with fertile valleys between, of which the great valley of Virginia is the largest and best known. In Pennsylvania the summits vary from 800 to 2,500 feet. Toward the south the chains become more numerous and in Virginia the Peaks of Otter reach 4,000 feet. The extreme eastern range is called the Blue Ridge, the extreme western the Cumberland Mountains, or, more properly, Plateaus, while the high range or ranges between are, in general, called the Alleghanies.

From the New River south the system becomes much more complex. The main chain, hitherto called the Blue Ridge, is deflected to the west, and for 250 to 300 miles, in a circuitous chain, under the names of Iron, Stone, Bald, Great Smoky, and Unaka Mountains, forms the boundary line between North Carolina and Tennessee, rising frequently to heights exceeding 6,000 feet; while the more easterly range, retaining the name of Blue Ridge, and finding its southern terminus at Cæsar's Head, in South Carolina, where it turns abruptly to the northwest, reaches even loftier altitudes, Mitchell's high peak being accredited with 6,717 feet.

In North Carolina these two ranges are more than 50 miles apart, are partially connected by transverse ranges, and, for more than 100 miles, constitute a great central plateau, like that of Colorado on a small scale.

As says Prof. Guyot, "Here then through an extent of more than 150 miles the mean height of the valley from which the mountains rise is more than 2,000 feet. The mountains which reach 6,000 feet are counted by scores, and the loftiest peaks exceed 6,700 feet, while at the north, in the group of the White Mountains, the base is scarcely 1,000 feet, the gaps 2,000 feet, and Mount Washington, the only one which rises above 6,000 feet, is still 400 feet below the Black Dome of the Black Mountains. Here then, in all respects, is the culminating region of the vast Appalachian system."

The eastern chain, or Blue Ridge is still the watershed, and, on the Atlantic slope, gives birth to the Roanoke, Catawba, Broad, Saluda, and Savannah rivers; while on the other side this area of mountains and plateaus is separated by transverse chains into many deep basins, at the bottom of each one of which runs one of those mountain streams, which are compelled to cut their way to the Tennessee through gaps, gorges, and defiles in the very heart of this mighty chain, giving us some of the most picturesque scenery

to be found on the continent. Among these, the New, Watauga, Nolichucky, and French Broad are the best known.

In the midst of this region, with all three ranges in sight, stands Roan Mountain, Laurentian in age, the State line crossing it at an altitude of 6,391 feet, as determined by the mean of my barometrical observations—and on and about this mountain it was my good fortune to stay from June 25th to August 30th.

Notes upon some of the peculiarities of the region, as contrasted with the northern Appalachian, will be my apology for asking your attention.

I. The Uniformity of Elevation.

Standing on the summit of Roan, we look into seven different States, and command a horizon of 30 to 80 miles. On the north and west the eye catches the Cumberland range in the horizon, beyond the great Tennessee plateau, which is traversed by the Clinch and a score of other ranges, but all as level as if designed for railroad embankments.

On the south and east there is a wilderness of mountains. Guyot gives 50 to 60 with altitudes exceeding 6,000 feet, and yet the highest is only 6,717 feet, and perhaps 40 of them fall between 6,000 and 6,500, while hundreds of others are above 5,000. The valleys rarely go below 3,000 feet. The railroad after leaving Lynchburg reaches 1,000 feet in a few miles, and from that point for nearly 300 miles never goes below 1,500 feet, its highest summit being at 2,550 feet.

II. Uniformity of Temperature.

During nine weeks the mercury once indicated 75°, seven times 70° +, once 45°, three times 50°, the general daily variation being between 55° and 65°. The spring, a few rods from the hotel, has a temperature of 45°. Equally remarkable was the uniformity of atmospheric pressure the highest barometer being 24.19, and the lowest 23.87, or a difference of only 0.32 inches. No wind had a velocity of more than twenty miles an hour, and seldom did it reach ten.

III. Fertility of the Summit.

Instead of the upper 1,000 feet being, as in most of the northern Appalachian peaks reaching an altitude of over 5,000 feet, a pile

of barren rocks, with lichens their only vegetation, the summit of Roan, and many other peaks, is a smooth, grassy slope, of the most vivid green, dotted with clumps of *Alnus viridis*, and *Rhododendron catawbiense*, the soil one or two feet in depth, rich and black. How this amount of humus was accumulated on these summits, and what cause destroyed the forests which its existence would seem to indicate as formerly existing, are questions not easily answered.

The valleys are very fertile, and adapted to almost any crop.

At an elevation of 3,000 to 4,000 feet occurs a belt of the most magnificent forest trees I have ever seen—hundreds of chestnuts, sugar maples, lindens, tulip trees, yellow birches, buck-eyes—some from 4 to 7 feet in diameter, and rising 70 to 80 feet without a limb. One chestnut measured 24 feet in circumference, and one black cherry measured 19 feet. Thorn bushes are as large as old apple trees with dwarf buck-eyes and yellow birches, looked like old orchards of vast extent.

IV. Flora.

Ascending the mountain, the vegetation takes on a northern aspect. Hemlocks abound till near the summit, where they are replaced by *Abies Fraseri*, the characteristic species of these summits.

Anemone nemorosa, *Oxalis acetosella*, *Rubus odoratus*, *Ribes lacustre* and *prostratum*, *Aster acuminatus*, *Habenaria articulata*, *Veratrum viride*, *Lycopodium lucidulum*, and similar species, remind one of the woods of Maine or New Hampshire.

The peculiar flora of the upper 1,000 feet, greatly resembles in habit that of the White Mountains, but very few species are the same. *Paronychia argyrocoma*, *Lycopodium selago* and *Alnus viridis*, are almost the only plants that occur to me as identical in the two localities, and these in the White Mountains are found in Crawford Notch, while in Roan they are near the summit. *Arenaria groenlandica* is replaced by *A. glabra*, *Solidago thyrsoides* by *S. glomerata*; *Geum radiatum* of the North is a variety of that found here; the two dwarf *Nabali* of White Mountains are represented by a new species, *N. roanensis*, *Rhododendron lapponicum* (four inches high) by magnificent *R. catawbiense*, covering the summit with its domes of inflorescence six to eight feet in diameter, *Castilleja pallida* by *C. coccinea*.

So that, in general, the species peculiar to these mountains are hardly sub-alpine, and thus continuous with similar species further

north, but are rather apparent instances of local variation, many species being confined to very limited localities.

On Mount Washington, a few rods will often give the same plant in bud, flower, and fruit, as a north or south exposure, a precipice, or a snow-drift may retard or accelerate growth; but on these southern mountains no such difference obtains any more than in the valleys below.

On this communication Mr. J. W. POWELL remarked that the uniformity in the altitudes of the peaks is a feature resulting from the fact that the general mass out of which they have been carved by erosion possesses a plateau structure. The elevation of that region was distributed in its effects with an approach to uniformity over a wide extent of country, and was unaccompanied by those sharp flexings or the protrusions of abrupt mountain cores, which are encountered in some portions of the Appalachians and other mountainous regions. The individual masses and ranges in the Cumberland region are the work of erosion—the general process of land sculpture acting upon a broad platform, excavating broad valleys and narrow gorges, and leaving the peaks and ridges as cameos—mere remnants left in the general degradation of the whole region. Prof. Powell exemplified the process by citing the Uinta Mountains as a broad platform similarly carved by an extensive erosion.

The following paper was read by LESTER F. WARD, entitled—

FIELD AND CLOSET NOTES ON THE FLORA OF WASHINGTON
AND VICINITY.

[Abstract.*]

Introductory Remarks.

This paper has resulted from a suggestion made to the writer in the spring of 1880, by a member of the Committee on Publications of this Society, relative to the need that exists for some special

* Mr. Ward's communication presented to the Society only a brief notice of the principal points of a monograph which he had prepared upon the flora of the District of Columbia. In view of the local character of his subject, and of the thorough and commendable manner in which it had been elaborated, the Committee on Communications recommended, and the General Committee authorized, the printing of a very full and copious abstract of the paper, which is given herewith.

treatise on the flora of this vicinity, and for a new and revised catalogue of the plants. While there now exists a provisional catalogue containing most of the species which have been collected or observed by botanists during the past six or seven years, it consists of so many small annual accretions, due to constant new discoveries, and contains withal so many blemishes and imperfections, incident to its hasty compilation and irregular growth, that it has ceased, in great part, to meet the demands of the present time. The elaboration of a systematic catalogue of the local flora was not, however, at the outset at all contemplated, but merely the presentation of certain notes and special observations on particular species, which had been made in the course of some nine years of pretty close attention to the vegetation, and somewhat varied and exhaustive field studies in this locality.

The flowering-time of most species here is much earlier than that given in the manuals, and is, moreover, in many cases, very peculiar and anomalous, rendering it important to collectors as well as interesting to botanists to have it definitely stated for a large proportion of the plants. It being thus necessary to extend the enumeration so far, it was thought that the remainder might as well be added, thus rendering it a complete catalogue of all the vascular plants known to occur here at the present time. To these has been appended the list of *musci* and *hepaticæ* prepared by the late Mr. Rudolph Oldberg for the *Flora Columbiana*, which has been left unchanged except in so far as was required to make it conform strictly to Sullivant's work which has long been the standard for this country. Dr. E. Foreman has also furnished the names of a few of the *Characeæ* collected by himself, and named by Prof. Farlow, of Cambridge, which, in the present unsettled state of the classification of the cryptogams, have, for convenience, been placed at the foot of the series.

In undertaking this compilation I have endeavored to resist the usual temptation of catalogue makers to expand their lists beyond the proportions which are strictly warranted by the concrete facts as revealed by specimens actually collected or species authentically observed; but have been content to set down only such as I can either personally vouch for, or as are vouched for by others who have something more substantial than memory to rely upon; preferring that a few species actually occurring but not yet seen should be omitted and afterwards supplied, rather than that others, sup-

posed to exist, but which cannot be found, should stand in the catalogue to be apologized for to those who would be glad to obtain them. A few species, however, which are positively known to have once occurred within our limits, but which have been obliterated within the recollection of persons now living, have been retained, as well as several of which only a single specimen has been found; but in all such cases the facts are fully stated in the notes accompanying each plant.

Range of the Local Flora.

The extent of territory which has of late years been tacitly recognized by botanists here as constituting the area of what has been called the *Flora Columbiana* is limited on the north by the Great Falls of the Potomac, and on the south by the Mount Vernon estate in Virginia, and Marshall's just opposite this on the Maryland side of the river, while it may reach back from the river as far as the divide to the east, and as far westward as the foot of the Blue Ridge, so as not to embrace any of the peculiarly mountain forms. Practically, however, the east and west range is much more restricted and only extends a few miles in either direction.

Comparison of the Flora of 1830 with that of 1880.

Washington and its vicinity has long been a field of botanical research. The year 1825 witnessed the dissolution of the *Washington Botanical Society*, which had for many years cultivated the science, and the same year also saw the formation of the *Botanic Club*, which continued the work, and in one respect, at least, excelled the former in usefulness, since it has handed down to us of the present generation a valuable record in the form of a catalogue of the plants then known to exist in this locality. This catalogue, which was fittingly entitled *Floræ Columbianæ Prodromus*, and claimed to exhibit "a list of all the plants which have as yet been collected," though now rare, and long out of print, is still to be found in a few botanical libraries.

I have succeeded in securing a copy of this work, and have been deeply interested in comparing the results then reached with those which we are now able to present. A few of these comparisons are well worth reproducing.

It should be premised that the *Prodromus* is arranged on the

artificial system of Linnaeus, so that before the plants could be placed in juxtaposition they required to be re-arranged. This, however, was not the principal difficulty. Such extensive changes have taken place in the names of plants during the fifty years which have elapsed since that work appeared, (1830,) that it is only with the greatest difficulty that they can be identified. After much labor, I have succeeded in identifying the greater part of them, and in thus ascertaining about to what extent the two lists are in unison. This also reveals the extent to which each overlaps the other, and thus affords a sort of rude index to the changes which our flora has undergone in half a century. There are, however, as will be seen, many qualifying considerations which greatly influence these conclusions and diminish the value of the data compared.

The whole number of distinct names (species and varieties) enumerated in the *Prodromus* is 919. Of these 59 are mere synonyms or duplicate names for the same plant, leaving 860 distinct plants. I have succeeded in identifying 708 of these with certainty as among those now found, and six others, not yet clearly identified, should probably be placed in this class. This leaves 146 enumerated in the old catalogue which have not been found in recent investigations. [A classified list of these plants was presented and commented upon somewhat in detail.]

With regard to these 146 species, it must not be hastily concluded that they represent the disappearance from our flora of that number of plants. While they doubtless indicate such a movement to a certain extent, there are ample evidences that many of them can be accounted for in other ways. After careful consideration, I have been able to divide them into four principal classes arising out of—

1st. Errors on the part of those early botanists in assigning to them the wrong names.

2d. The introduction into the catalogue of adventitious and even of mere cultivated species, never belonging to the flora of the place.

3d. The undue extension by those collectors of the range of the local flora so as to make it embrace a portion of the maritime vegetation of the Lower Potomac or the Chesapeake Bay, and also the mountain flora of the Blue Ridge.

4th. The actual extermination and disappearance of indigenous plants during the fifty years that have intervened since they made their researches.

The assignment which I have made of each species to its appropriate class has been of course in great part conjectural and may be incorrect in many cases, while another botanist might have differed considerably in regard to special plants; yet it is not based on a general judgment drawn from my acquaintance with the present flora, but upon several kinds of special evidence, which in numerous instances has reversed my *prima facie* decision.

In the first place, I have carefully compared the range of each species as given in the text books to determine the probabilities for or against its being found here, and in the second place I have compared this list with the corresponding one of the species now found but not enumerated in the *Prodromus*. I have also endeavored to make due allowance on the one hand for the tendency above referred to to swell catalogues beyond their proper limits, and on the other for the well known fact that every flora is at all times undergoing changes.

It must not be forgotten, either, that half a century ago the surface of the entire country here must have presented a very different appearance from that which it presents now. The population of the District of Columbia in 1830, when it included a portion of Virginia, was only 39,834. It is now, exclusive of the Virginian part receded to that State, 177,638. To render the comparison more exact we may add to the latter number the present population of Alexandria county, amounting to 17,545, and we have in the place of 39,834 a population on substantially the same area of 195,183, or about five times as large. The population of Maryland in 1830 was 447,040; in 1880 it was 934,632, or considerably more than twice as large. That of Virginia in 1830 was 1,211,405. Virginia and West Virginia, embracing the same territory, now number 2,131,249 the population not having quite doubled: the retardation, however, as compared with Maryland, is doubtless due entirely to influences affecting the southern counties. There were doubtless large areas of primeval forest then within our limits which are now under cultivation, and a much greater variety of soil and woodland was then open to the researches of the botanist. As a consequence we ought to expect that it would sustain a much richer flora.

The general result at which I arrive by the process adopted may be summed up as follows:

1st. That 43 of these names, or 29 per cent. of them, belong to the first class and constitute errors in naming.

2d. That 12 of these plants, or 8 per cent., belong to the second class, or were simply cultivated species, and never belonged to this flora.

3d. That 10 of them, or 7 per cent., belong to the third class and were collected beyond the reasonable limits of our local flora.

4th. The remaining 81, or 56 per cent., belong to the fourth class, and represent *bona fide* discoveries in 1830 of species which either do not now occur or are so rare as to have escaped the investigations of the present generation of botanists.

With regard to the first of these classes, the large number of errors in naming cannot be considered any derogation from the ability or fidelity of the compilers of the *Prodromus* or their immediate predecessors, when we remember the very unsettled state that American botany was in at that time. Both names and authorities were badly confused, and errors were committed even by the most experienced botanists. For example, their *Corydalis glauca* as probably also their *C. aurea*, meant *C. flavula* which is now abundant, but omitted by them. Their *Arabis stricta* might have been *A. hirsuta* or *A. patens*, which are both now rare, though it was more probably a form of *A. laevigata*, as they seemed to be specially fond of drawing nice distinctions and expressing them by synonyms. Varieties, however, were scarcely recognized by them, the trinomial theory being then in its infancy. I might thus proceed to discuss all their supposed errors, but this is not necessary.

The second and third classes, amounting together to 16 per cent. of the alleged excess over the present flora, consist also of errors, but errors which it is much less easy to palliate. It is natural to wish to make as large a showing as possible, and the temptation to insert into a catalogue everything which by any construction can be claimed to belong there is rarely resisted. To show that this propensity still exists, it may be remarked that of the 1054 species enumerated in the preliminary catalogue of plants of this vicinity, published by the Potomac Side Naturalist's Club in 1876, 89, or about 8½ per cent. are now admitted by all not to have been seen here at that time, and have never been found by any one since, although nearly three hundred other species have since been added to the flora. This is certainly not a scientific method to proceed upon, and as already remarked, the present effort aims to eliminate to a great extent this source of error.

The 81 species constituting the fourth class remain, therefore, the

only ones to which any special interest attaches and for the determination of which the present somewhat laborious analysis of this ancient document has been undertaken. For these, the botanists of our times should make diligent search and perchance a few of them may still be found. Assuming that they no longer exist, they do not represent the whole number of plants that have disappeared from our flora during the interval of fifty years. This could be only on the assumption that the *Prodromus* was a complete record of the flora at the time. This it certainly is not. The aggregate number, exclusive of synonyms or duplicated names, which it contained was, as we saw, 860, which includes one cellular plant, viz: *Achara*. We now identify, counting as was then done, species and varieties, 1249 distinct vascular plants. While no doubt many of these have been freshly appearing while others have been disappearing, still, from the considerations above set forth, it is highly probable that the indigenous flora of 1830 was considerably larger than that of 1880, and may have reached 1400 or 1500 vascular plants. It would appear, therefore, that only a little over half the plants actually existing were discovered by the botanists of that day, and enumerated in their catalogue. If the proportion of disappearances could be assumed to be the same for species not discovered as for those discovered by them, this would raise the aggregate number to considerably above one hundred, and perhaps to one hundred and twenty-five.

The great number of present known species not enumerated in the *Prodromus*, some of them among our commonest plants and amounting in the aggregate to 535 species, is another point of interest, since, after due allowance has been made for mistakes in naming them, it remains clear on the one hand that these researches must have been, compared with recent ones, very superficial; and on the other, that, not to speak of fresh introductions, many plants now common must have then been very rare, otherwise they would have proved too obtrusive to be thus overlooked.

Localities of Special Interest to the Botanist.

The flora of a wild region is always more uniform than that of one long subjected to human influences. The diversity in the former is a natural consequence of the corresponding diversity in the surface and other physical features. In the latter it is due to condi-

tions arbitrarily imposed by man. A primeval flora is usually more rich in indigenous species, but the artificial changes caused by cultivation often offset this to a great extent by the introduction of foreign ones. This, however, greatly reduces its botanical interest.

In many respects the botanist looks at the world from a point of view precisely the reverse of that of other people. Rich fields of corn are to him waste lands; cities are his abhorrence, and great areas under high cultivation he calls "poor country;" while on the other hand the impenetrable forest delights his gaze, the rocky cliff charms him, thin-soiled barrens, boggy fens, and unreclaimable swamps and morasses are for him the finest lands in a State. He takes no delight in the "march of civilization;" the ax and the plow are to him symbols of barbarism, and the reclaiming of waste lands and opening up of his favorite haunts to cultivation he instinctively denounces as acts of vandalism. In him more than in any other class of mankind the poet's injunction—

"Woodman, spare that tree,"

touches a responsive cord. While all this may seem as absurd to some as does the withholding from tillage of great pleasure grounds in the form of hunting parks for the landed sporting gentry of Northern and Western Europe, still, when these parts of the world are compared with the artificially made deserts of Southeastern Europe and Western Asia, caused by the absence of such sentiments, there may, perhaps, be dimly recognized a "soul of good in things evil," if not a soul of wisdom in things ridiculous.

After the protracted subjection of a country to the conditions of civilization it gradually comes about that while the greater part of the surface falls under cultivation, more or less thorough, and the botanist is ultimately excluded from it, there will remain a few favored spots, which, from one cause or another, will escape and continue to form his favorite haunts. In the vicinity of large rivers, giving greater variety to the surface, or of rugged hills or mountains, this will be especially the case. As a country grows old large estates in the vicinity of cities fall into the possession of heirs who are engaged in mercantile or professional business, and neglect them, or they come into litigation lasting for years, and are thus happily abandoned to nature. These and other causes have operated in an especial manner in the surroundings of Washington,

and there thus exist a large number of these green oases, as it were, interspersed over the otherwise botanical desert.

In consequence of this fact it requires experience in order to improve the facilities which the place affords. A botanist unacquainted with the proper localities for successful collection might spend a month almost in vain, and depart with the conviction that there was nothing here to be found. It may not be wholly peculiar, but these favored localities are here often of very limited extent, and in situations which from a distance afford no attraction to the collector. Civilization is, however, very perceptibly encroaching upon many of them, and it is feared that in another half century little will be left but a few bare rocks or inaccessible marshes.

In naming localities the principal authorities relied upon are: 1. A recent *Atlas of fifteen miles around Washington, including the County of Montgomery, Md., Compiled, Drawn, and Published from Actual Surveys*, by G. M. Hopkins, C. E.: Philadelphia, 1879; and, 2, a military map of Northeastern Virginia, published in the work of General J. G. Barnard, on the *Defences of Washington*, 1821.

From the former the names of many roads, streams, estates, &c., have been obtained, while from the latter those of forts, batteries, &c., are often employed as more convenient. In this respect, however, much remains to be desired. While the military map is antiquated, the other is frequently defective in omitting what is required and incorrect in erroneously locating streams and other objects well known to the writer. In his extensive rambles he has learned many local names not found on the map, and in a few cases of special botanical interest, where names are wholly wanting, he has long been in the habit of designating the localities by names of his own christening, and for which he offers no apology.

The following are a few of the principal places of botanical interest which will be found to recur most frequently in the notes, and for this reason brief descriptions of them are appended.

1. *The Rock Creek Region*.—Rock Creek which forms the boundary line between Washington and Georgetown (West Washington), has escaped to a remarkable degree the inroads of agriculture and population. For the greater part of its length within the District of Columbia its banks are still finely wooded for some distance back, and afford a rich and varied field for botanical exploration. The character of the surface along Rock Creek is most beautiful and picturesque, often rocky and hilly with frequent deep ravines

coming down into the usually narrow bottom through which the creek flows. The stream itself is full of the most charming curves and the whole region is an ideal park. No one can see it without thinking how admirably it is adapted for a National Park. Such a park might be made to extend from Oak Hill Cemetery to the Military Road opposite Brightwood, having a width of a mile or a mile and a half. Not only every botanist but every lover of Art and Nature must sigh at the prospect, now not far distant, of beholding this region devastated by the ax and the plow. The citizens of Washington should speedily unite and strenuously urge upon Congress the importance of early rescuing this ready-made National Park from such an unfortunate fate.*

The Rock Creek Region is divided, so far as the designation of localities is concerned, into six sections. The first embracing the series of groves from Georgetown to Woodley Park on the right bank of the creek, is called Woodley. This section embraces several interesting ravines and in it are found many plants rare elsewhere, such as *Chamaelirium*, *Carolinianum*, *Cypripedium pubescens*, *Hesperis matronalis* and *Liparis Laeslii*. In it is also a grove of the Hercules club (*Aralia spinosa*.) On the left bank of the creek lie the Kalorama Heights and some open woodland.

The *Woodley Park* section extends to the ravine which comes down opposite the old brick mill-ruin known as the Adams Mill. The timber here has been thinned out recently by the proprietors but not cleared off, and the vegetation has undergone a marked change. Several interesting plants have been found in Woodley Park, including the rare *Obolaria Virginica*, and the beautiful *Spiraea aruncus*. Above this the timber is heaviest on the left bank and some very fine ravines occur, at the head of one of which is a magnolia and sphagnum swamp where *Veratrum viride* and *Symplocarpus foetidus* keep company with *Gonolobus obliquus* and *Pyrus*

* It is remarkable that when committees of Congress have been appointed, as has several times been done, to consider a site for a National Park, they have usually looked in other directions and have seemed to ignore the existence of this region, which is certainly the only one that possesses any natural claims. A mere carriage ride through such parts as are traversed by roads is wholly insufficient to afford an adequate idea of its merits from this point of view. For the greater part of the distance mentioned above this region is accessible only to footmen.

arbutifolia. Here, too, though well up towards the ford, has been found *Polemonium reptans*, not seen elsewhere.

This third section terminates at Piney Branch, and from here to Pierce's mill, and as far above as the mouth of Brood Branch, the fourth section extends. This section is well wooded on both sides and includes the enchanting Cascade run which leaps down over the most romantic rocks. Near Pierce's mill are many trees and shrubs, planted there years before, but now well naturalized. Among these are *Aralia spinosa*, *Xanthoxylum Americanum*, *Acer saccharinum*, *Pinus strobus*, and *Carya alba*. Below the mill on the creek bottom is a long-abandoned nursery of *Populus alba* and *Acer dasycarpum*, from which many of the trees of the city may have been supplied.

From Broad branch to the Military road is the fifth and perhaps most interesting section of the Rock Creek Region. On the left bank lie the once noted Crystal Springs, and though the buildings are removed, the springs remain unchanged. Here have been found *Ophioglossum vulgatum*, *Anychia dichotoma*, and *Perilla oei-moides*, as well as *Tipularia discolor*. On the right bank and above Blagden's mill is a bold bluff in a short bend of the creek forming a sort of promontory upon which there grows *Gaultheria procumbens*, the winter-green or checkerberry, this being its only known locality within our limits. Half a mile farther up and back upon the wooded slope is the spot on which stand a dozen or more fine trees of the Table Mountain Pine, (*P. pungens*.) Here also was first found *Pycnanthemum Torreyi*.

To these there must be added a sixth section extending from the Brightwood road to the north corner of the District of Columbia which lies near Rock Creek. For the first mile there is little of interest, the cultivated land approaching the creek and the low hills near its banks being covered with a short second growth of scrub pine and black-jack. But above the Claggett estate on the right bank, and to some extent on both sides, lies the largest forest within our limits. This wood belongs, I learn, to the Carroll estate and is so designated in this catalogue. In it have been found very many most interesting plants. It was the first extensive tract found for the crowfoot (*Lycopodium complanatum*) and still constitutes the most reliable and abundant source known of this plant. Its present fame, however, rests upon its hybrid oaks, of which some most interesting forms have been found there. [See Field and Forest,

October and November, 1875; Botanical Gazette, October, 1880, p. 123.] Here also grows very sparingly *Microstylis ophioglossoides*, and quite abundantly *Pyrola elliptica* and *P. secunda*. It is also a rich locality for many other species rare elsewhere.

2. *The Upper Potomac Region*.—The flora of the left bank of the Potomac is, in many respects, very unlike that of any other locality within our limits. A mile above Georgetown, and commencing from the recently constructed outlet lock of the Chesapeake and Ohio canal, there exists a broad and low strip of country formerly known by the name of Carberry Meadows, lying between the canal and the river, and extending to the feeder of the canal, a distance of about three and a half miles. This interval is relieved by two convenient landmarks, viz., one mile above the outlet lock, a grist-mill and guano factory, popularly known as Eads' mill; and a mile further, the celebrated Chain Bridge. Little Falls, proper, begin a hundred yards above the bridge, and extend half a mile or more. The region above the bridge will, therefore, be designated as Little Falls. The flats terminate in a remarkable knoll or small hillock of very regular outline and abrupt sides, which, from the combined effects of the feeder on one side, and large overflows from it below, becomes practically an island, and is well known to all as High Island. These river flats are, in most places, covered with large boulders of the characteristic gneiss rock of the country. In some parts the surface is very rough, and numerous pools or small ponds of water occur. Overflows and leakages from the canal cause large sloughs and quagmires, while annual ice-gorges crush down the aspiring fruticose vegetation. All these circumstances lend variety to the locality, and, as might be expected, the flora partakes largely of this characteristic. It would prolong this sketch unduly to enumerate all the rare and interesting plants which this region has contributed to our vegetable treasures, but conspicuous among them are *Polygonum amphibium*, var. *terrestre*, *Isanthus cœruleus*, *Herpestis nigrescens*, *Brasenia peltata*, *Cyperus virens*, and *Nesaea verticillata*, all of which recur below Ead's mill; *Ammannia humilis*, a remarkable variety of *Salix nigra*, (*S. nigra* var. *Wardi*, *Bebb.*) *Salix cordata*, and *S. longifolia*; as also *Spiranthes latifolia*, and *Samolus valerandi* var. *Americanus*, *Vitis vulpina* and *Panicum pauciflorum*, which may be found between this point and the bridge, while at the Little Falls we are favored with *Paronychia dichotoma*, *Oenothera fruticosa*, var. *lineare*

(very distinct from the type) and *Ceanothus ovatus*: also *Ranunculus pusillus* and *Utricularia gibba*. But rich and varied as are these lower flats, they are excelled by High Island, the flora of which is by far the most exuberant of all within the knowledge of botanists. Here we find *Jeffersonia diphylla*, *Caulophyllum thalictroides*, *Erigenia bulbosa*, *Silene nivea*, *Valeriana pauciflora*, *Erythronium albidum*, *Iris cristata*, and a great number of others of our most highly prized plants, many of which are found nowhere else.

Above the feeder is a series of islands in the river lying for the most part near the Maryland shore, and to which the maps, so far as I can learn, assign no names. The first of these lies well out in the river, and has been made to form a part of the feeder-dam. It is low and frequently overflowed, and has not, as yet, furnished many rare plants, though here *Arabis dentata* and some others have been found. It has been designated *Feeder-dam Island*. The second is half or three-quarters of a mile above, lies higher, and is covered with a very dense and luxuriant herbaceous vegetation and fine trees, chiefly of Box Elder, *Negundo aceroides*, from which circumstance and the peculiar impression which the long gracefully pendent staminate flower of these trees produced on the occasion of its first discovery by a botanical party it received the name of *Box Elder Island*. The third island is a short distance above the last, has a more elevated central portion and a similar vegetation. Here was found, on our first visit, and also on subsequent ones, *Delphinium tricorne*, and for this contribution to the Flora Columbianiana it was christened *Larkspur Island*. The fourth of these islands is, in many respects, similar to the two last described, and upon it stands the only indigenous specimen of *Acer saccharinum* yet found here. It has, therefore, been appropriately named *Sugar-maple Island*. *Erythronium albidum*, *Trillium sessile*, *Jeffersonia diphylla* and similar species abound on all these islands, while on the Larkspur Island, besides the *Delphinium*, has also been found *Phacelia Purshii*. The beauty of these natural flower-gardens in the months of April and May is unequaled in my experience. The light and rich alluvial soil causes the vegetation to shoot up with magic rapidity at the first genial rays of the vernal sun, and often the harbinger of spring, *Erigenia bulbosa*, true to its name, will greet the delighted Rambler in late February or early March.

The opposite, or Virginia side of the Upper Potomac, consists entirely of bold bluffs, interrupted by deep ravines, often contain-

ing wild torrents and dashing cascades. Here the flora, though less rich and varied, is also characteristic and interesting, and embraces, among other rare things, *Rhododendron maximum*, *Iris crestata*, *Scutellaria saxatilis*, *Pycnanthemum Torreyi*, *Solidago rupestris* and *S. virga-aurea*, var. *humilis*. On the Maryland side and a mile above the uppermost point thus far mentioned, is the Cabin John run, which the botanist celebrates more for its walking fern (*Camptosorus rhizophyllus*) than for the world-renowned arch that spans it.

The next most prolific source of interesting plants is the region of the Great Falls. The collecting grounds begin a mile or more below at Broad Water. On both sides of the canal the country is excellent, rocky and wooded, with stagnant pools and sandy hillocks. On these rocks grow *Sedum telephoides* and near Sandy Landing are found *Vitis vulpina*, *Arabis patens*, *A. hirsuta* and *Triosteum angustifolium*. In the pools have been found *Carex decomposita*, *Potamogeton hybridus* and *P. pauciflorus*, while on a rocky headland a large "water-pocket" has yielded my only specimen of the white water lily (*Nymphaea odorata*). *Crataegus parvifolia*, *Rumex verticillatus*, *Steironema lanceolatum*, and last but not least, *Nasturium lacustre*, have also rewarded my researches in this singular and rather weird region.

On the opposite side of the river the site of the ancient canal around the Falls has proved very fertile in botanical trophies. *Polygala ambigua* is found near the boat landing, while by climbing the cliffs below this point the native of more northern climes may gaze once more upon his familiar Hemlock Spruce, *Tsuga Canadensis*. Difficult Run, a mile farther down, though indeed difficult of approach, repays the effort with *Podostemon ceratophyllus*, *Smilacina stellata*, *Potamogeton Claytonii*, and numerous other herbal treasures.

3. The Lower Potomac Region.

Passing next to the lower Potomac, the localities of special interest are, 1. Custis Spring, opposite the Arlington estate, with the extensive marsh below, where *Sagittaria pusilla*, *Discopleura capillacea*, *Cyperus erythrorhizus*, and other rare species are alone known to grow. 2. The point and bay below Jackson City, known as Roach's run, where are found, among others, *Scrophularia nodosa*,

Tripsacum dactyloides and *Pycnanthemum lanceolatum*. 3. Four Mile run, half way to Alexandria, not yet sufficiently explored, including the vicinity of Fort Scott to the northwest, where *Clematis ochroleuca* and *Asclepias quadrifolia* may be collected; and, 4. Hunting creek, a large estuary below Alexandria, including Cameron run, the stream which debouches into it, with its tributaries, Back Lick run and Holmes run, which unite to form it. Here have been found, at various points, *Clematis ochroleuca*, *Gonolobus hirsutus*, *Itea Virginica*, *Geranium columbinum*, *Micranthemum Nuttallii*, *Habenaria virescens*, *Quercus macrocarpa*, *Carex gracilima*, *Geum strictum*, *Galium asprellum*, and very many other rare plants.

On the left bank of the lower Potomac the chief locality of interest is a large wooded area below the Government Hospital for the Insane. This has proved a rich hunting ground for the botanist, and has yielded *Carex pallescens*, *Carex Woodii*, *Gonolobus hirsutus*, *Silene armeria*, *Parietaria Pennsylvanica*, *Myosotis arvensis*, *Scutellaria nervosa*, &c., &c. *Asplenium angustifolium* is known only at Marshall Hall, where it has been reported by Mr. O. M. Bryan, while opposite Fort Foote Mr. Zumbrock has found *Myriophyllum spicatum*, and opposite Alexandria Professor Comstock and Miss Willets have discovered *Plantago cordata*.

4. The Terra Cotta Region.

This embraces some low grounds and undulating barrens near the terra cotta works, at Terra Cotta Station, on the Metropolitan Branch of the Baltimore and Ohio railroad, three miles from the city, and also a small swamp a quarter of a mile beyond, and to the eastward. Here on the dry ground have been found *Onosmodium Virginianum*, *Lespedeza Stuevei*, *Clitoria Mariana*, and *Habenaria lacera*; and in the swamp *Aster æstivus*, *Solidia stricta*, *Woodwardia Virginica*, *Asclepias rubra*, *Poterium Canadense*, and numerous other plants rare or absent in other localities.

5. The Reform School Region.

This locality is very limited in extent, but has proved one of the most fertile in botanical rarities. Its nucleus consists of a little swampy spot a short distance to the south of the National Reform School, in which is located a beautiful spring; but the woody

tract of country surrounding this and stretching southward and eastward some distance has also proved very fruitful. In the different portions of this region have been discovered *Phlox maculata*, *Melanthium Virginicum*, *Bartonia tenella*, *Lespedeza Stuvei*, *Desmodium Marilandicum* and *D. ciliare*, *Buchnera Americana*, *Fimbri-stylis capillaris*, *Quercus prinoides*, *Carex bullata*, and *Gentiana ochroleuca*, most of which do not occur at all elsewhere.

6. The Holmead Swamp Region.

Like the last, this locality is quite circumscribed in area, but like it, too, it is rich in interesting plants. It occupies a ravine leading to Piney Branch from the east at the point where the continuation of Fourteenth street crosses that stream. The road connecting the last named with the Rock Creek Church road, and which is called Spring street, follows this valley. The collecting grounds are on the south side of this road and in the springy meadow along the rill. The timber has long been cut off, but the boggy character of the ground has thus far protected it from cultivation. The pasturing of animals on it during a portion of the year has latterly become a serious detriment to the growth of plants. Mr. Holmead, who owns it and lives near by, has kindly permitted botanists to investigate it for their purposes. Here have been found *Ludwigia hirsuta*, *Drosera rotundifolia*, *Asclepias rubra*, *Xyris flexuosa*, *Fuirena squarrosa*, *Rhinchospora alba*, *Coreopsis discoidea* and the beautiful *Calopogon pulchellus* the most showy of our orchids.

In addition to these specially fertile tracts there are many other localities of great interest where valuable accessions to our flora have been made, and which will be particularly designated under the names of these species. It will suffice here to mention a wet meadow between the National Driving Park and Bladensburg, where, in a very diminutive spot, *Sarracenia purpurea*, *Viola lanceolata*, and *Carex bullata*, the two first wholly unknown elsewhere, have been discovered; a marsh a mile from Bladensburg, near the millrace, where only the majestic *Stenanthium robustum* has been seen; a little swamp near the Sligo creek, between the Riggs and Blair roads, where the Hartford fern (*Lygodium palmatum*) grows sparingly; and another between Bladensburg and the Maryland Agricultural College, where *Solidago elliptica*, *Ascyrum stans*, and *Lyco-podium complanatum*, var. *Sabinæfolium*, have been found. The

Eastern branch region is not specially rich in floral treasures, but on its banks and marshes some good things appear. *Habenaria virescens*, *Steironema laceolatum*, *Eleocharis quadrangulata*, *Scirpus fluviatilis*, *Ranunculus ambigens*, and *Salix Russelliana* are among these, though some of them are found elsewhere.

Flowering time of Plants.

It has already been remarked that most species flower at Washington much earlier than at points farther north or the dates given in the manuals. In consequence of this, a botanist unacquainted with this fact, and accustomed to those climates and to relying upon the books, would be likely to be behind the season throughout the year, and fail to get the greater part of the plants he desired. With all my efforts to make allowance for this fact, I have frequently been sorely disappointed and was at last driven to making a careful record, preserving and correcting it from year to year, of the *flowering time* of plants in this locality. The notes on this subject appended to nearly every species enumerated in the list embody the general results of these observations and may in the main be relied upon. The expressions used are not loose conjectures, but are in the nature of compilations from recorded data. In most cases an allowance of two weeks may be made for the difference in seasons though rarely more and often less. Certain plants, as for example, *Tipularia discolor*, flower at almost exactly the same time every year. Occasionally, however, one will vary a month or more in a quite unaccountable way. But any one who has watched the periodical changes of the general vegetation for a series of years and recorded his observations, will more and more realize the exactness even of these complex biological phenomena which depend so absolutely upon uniform astronomical events.

From this point of view the season which presents the greatest variation and also, for this and other reasons, the greatest interest is the spring. There are a few plants which may sometimes be found in flower here in January, such as *Stellaria media*, *Taraxacum dens-leonis* or *Acer dasycarpum* (collected Jan. 17, 1876, in the city) in favored places, but these will bloom at any time when a few days of mild weather with sunshine can come to revive them. There are, however, several strictly vernal species which bloom quite regularly in the latter part of February, such as *Symplocarpus fæ-*

tidus, *Chrysosplenium Americanum*, and often *Anemone hepatica*. The number regularly found in flower in March is quite large and in special years very large. It was of course impossible to make observations every day of any year, but taking a number of years my observations cover nearly every day of the spring season. As showing the number of these early vernal species and also how widely the seasons may differ, the following facts are presented:

In the year 1878 seventeen species had actually been seen in flower and noted up to March 24th. I did not go out again that year until April 7, when I enumerated forty-six additional species, making sixty-three in all up to that date. This was an exceptionally early season. The next spring, that of 1879, was a backward one, as is shown by the fact that while I had visited the same localities, and taken notes with equal care only thirty-three species had been seen in flower up to April 13th: twenty-nine species which had been seen in flower on April 7th, 1878, were not yet in flower in the same localities on April 13th, 1879. There appeared to be about three week's difference in these two seasons. The last season, 1880, was again an early one, though less so than 1878. It was, however, near enough to the average to render the facts observed of great value. The following are a few of them: On February 29th, seven species were seen in flower in the Rock Creek region. On April 4th, thirty were enumerated on the Virginia side of the Potomac, above the Aqueduct Bridge. On April 11th, eleven were seen in addition to those previously enumerated in the Eastern Branch region: and on the 18th of April, High Island was visited, and twenty-nine added to all previously recorded, three of which were then in fruit. The total to this date was therefore seventy species. This season I concluded was a week or ten days later than that of 1878, and as much earlier than that of 1879.*

* Since the above was written the present season (1881) has passed its vernal period. It has proved still more backward than 1879 and the latest spring thus far observed. On April 3d, I made my first excursion and visited the Virginia side of the Potomac above Rosslyn. Only 7 species were seen in flower including *Alnus serrulata* which doubtless can be obtained much earlier in ordinary years, but has been overlooked. Besides *Draba verna*, a January species, and *Anemone hepatica*, a February one, the only herbaceous flower found was *Sanguinaria Canadensis*. On April 10th, High Island was visited, but only 8 species could be added to the above 7, and several of these, as *Jeffersonia diphylla*, *Dicentra cucullaria*, *Saxifraga Virginiensis*, *Erythronium Americanum*, and *Stellaria pu-*

We may now inquire what some of these early plants are. The following have been observed in flower in February :

Chrysosplenium Americanum, February 17, 1878.

Anemone Hepatica, February 20, 1876.

Salix Babylonica, February 22, 1874.

Populus alba, February 22, 1874.

Draba verna, February 24, 1878.

Acer dasycarpum, February 24, 1878,

Stellaria media, February 29, 1880.

Cerastium viscosum, February 29, 1880.

Claytonia Virginica, February 29, 1880.

Acer rubrum, February 29, 1880.

Symplocarpus fœtidus, February 29, 1880.

To these should, perhaps, be added *Equisetum hyemale*, which was found February 17, 1878, near the receiving reservoir with the spikes well advanced, quite contrary to the books which make it fruit in summer.

In addition to the above, which may often also be seen later, the following have been noted flowering in March :

Populus alba, March 3, 1874,

Viola pedata, March 5, 1876.

Houstonia cœrulea, March 5, 1876.

Obolaria Virginica, March 5, 1876.

Dentaria heterophylla, March 8, 1874.

Poa brevifolia, March 8, 1874.

Capsella Bursa-pastoris, March 10, 1878.

Lamium amplexicaule, March 10, 1878.

Lindera Benzoin, March 10, 1878.

Epigaea repens, March 15, 1874.

Ulmus fulva, March 15, 1874.

Luzula campestris, March 15, 1874.

Saxifraga Virginiensis, March 16, 1879.

Sanguinaria Canadensis, March 17, 1878.

Sisymbrium Thaliana, March 17, 1878.

bera, were very sparingly out. Cold weather continued to the end of the third week in April, and on April 24th, when High Island was again visited and a thorough canvas made, only 22 additional plants could be found there, and the whole number seen to that date was 46. The conclusion was that up to that time the season was about three weeks later than that of 1880.

Salix tristis, March 17, 1877.
Populus grandidentata, March 21, 1880.
Corydalis flavula, March 22, 1874.
Thalictrum anemonoides, March 24, 1878.
Dentaria laciniata, March 24, 1878.
Antennaria plantaginifolia, March 24, 1878.
Erodium cicutarium, March 27, 1874.
Erigenia bulbosa, March 28, 1875.
Cardamine hirsuta, March 30, 1879.

It is about the first of April, especially in early years, that the vegetation seems to receive the greatest impetus. This is well shown by the following list of species seen in flower during the first week in April:

Ulmus Americana, April 1, 1873.
Jeffersonia diphylla, April 2, 1876.
Cardamine rhomboidea, April 2, 1876.
Stellaria pubera, April 2, 1876.
Thaspium aureum, April 2, 1876.
Euphorbia commutata, April 2, 1876.
Alnus serrulata, April 3, 1881.
Ranunculus abortivus, April 4, 1880.
Dicentra Cucullaria, April 4, 1880.
Arabis laevigata, April 4, 1880.
Viola tricolor. var. arvensis, April 4, 1880.
Vicia Caroliniana, April 4, 1880.
Amelanchier Canadensis, April 4, 1880.
Nepeta Glechoma, April 4, 1880.
Sassafras officinale, April 4, 1880.
Carpinus Americana, April 4, 1880.
Ostrya Virginica, April 4, 1880.
Erythronium Americanum, April 4, 1880.
Barbarea vulgaris, April 5, 1874.
Pedicularis Canadensis, April 5, 1874.
Mertensia Virginica, April 5, 1874.
Ranunculus abortivus, var. micranthus, April 7, 1878.
Ranunculus repens, April 7, 1878.
Asimina triloba, April 7, 1878.
Caulophyllum thalictroides, April 7, 1878.
Arabis dentata, April 7, 1878.

Barbarea praecox, April 7, 1874.
Sisymbrium Alliaria, April 7, 1878.
Viola cucullata, April 7, 1878.
Viola striata, April 7, 1878.
Viola glabella, April 7, 1878.
Ionidium concolor, April 7, 1878.
Silene, Pennsylvanica, April 7, 1878.
Cerastium vulgatum, April 7, 1878.
Cerastium oblongifolium, April 7, 1878.
Geranium, maculatum, April 7, 1878.
Oxalis corniculata, April 7, 1878.
Cercis Canadensis, April 7, 1878.
Potentilla Canadensis, April 7, 1878.
Thaspium trifoliatum, April 7, 1878.
Cornus florida, April 7, 1878.
Chrysogonum, Virginianum, April 7, 1878.
Senecio aureus, April 7, 1878.
Fraxinus viridis, April 7, 1878.
Phlox divaricata, April 7, 1878.
Lithospermum arvense, April 7, 1878.
Betula nigra, April 7, 1878.
Populus monilifera, April 7, 1878.
Arisaema triphyllum, April 7, 1878.
Erythronium albidum, April 7, 1878.
Trillium sessile, April 7, 1878.

My special observations on the vernal flowering time of plants extend about two weeks later or to the end of the third week in April, after which the great number of plants in bloom, including the amentaceous trees, render it difficult to pursue the investigation, while at the same time the facts become less valuable. The results for the second and third weeks of April, always excluding all previously enumerated, are as follows :

Arabis lyrata, April 9, 1876.
Fraxinus pubescens, April 11, 1880.
Salix cordata, April 11, 1880.
Salix purpurea, April 11, 1880.
Vaccinium corymbosum, April 12, 1880.
Carex platyphylla, April 12, 1880.
Poa annua, April 12, 1874.

- Thalictrum dioicum*, April 14, 1876.
Rhus aromatica, April 14, 1878.
Phlox subulata, April 14, 1878.
Arabis patens, April 18, 1880.
Cardamine hirsuta, var *sylvatica*, April 18, 1880.
Negundo aceroides, April 18, 1880.
Erigeron bellidifolius, April 18, 1880.
Krigia Virginica, April 18, 1880.
Sisyrinchium Bermudiana, April 18, 1880.
Carex laxiflora, April 18, 1880.
Carex Emmonsii, April 18, 1880.
Melica mutica, April 18, 1880.
Anemone nemorosa, April 19, 1874.
Viola cucullata, var. *cordata*, April 19, 1874.
Dirca palustris, April 19, 1874.
Carex Pennsylvanica, April 19, 1874.
Lathyrus venosus, April 21, 1878.
Ribes rotundifolia, April 21, 1878.
Salix nigra, var. *Wardi*, April 21, 1878.

We thus see that a single collector has in the course of eight year's operations actually observed and noted eleven species in bloom in February, 24 more in March, 51 additional in the first week of April, and 26 others during the second and third weeks of April or 112 up to April 21.

It should be remarked that there is no doubt that if the same localities in which the large numbers were observed on April 2 1876, April 4, 1880, and April 7, 1878 had been visited in the last days of March of those years quite a number of these plants would have been found sufficiently advanced to demand a place in the lists, and thus the month of March would have been credited with so many here set down for the first week in April. Probably, all things considered, not less than fifty species in certain favored seasons either reach or pass by their flowering-time by the end of March.

In arranging the above lists the order of dates has of course taken precedence, but where several are enumerated under one date the natural order is followed.

It is scarcely necessary to suggest a caution to collectors against relying upon these dates in making collections. They represent the earliest observations and not the average. In most cases an allowance of at least one week should be made for the full bloom-

ing of all the individuals of any given species. In all cases, however, one or more individuals were actually seen in flower and sufficiently advanced for collection, otherwise no note was taken. The *Carices* of course had not advanced to developed perigynia, and many plants whose inflorescence is centrifugal or centripetal, or which develop fruit while retaining their flowers, should be looked for at a later stage.

Autumnal Flowering.

One of the most interesting peculiarities of the flora of this vicinity is that of the second-blooming of vernal species, which in most cases takes place quite late in the fall. [See *Field and Forest*, April-June, 1878, Vol. III, p. 172.] In addition to the seven species observed and published in 1878, I have noted more than as many others manifesting this habit, and it is probable that still others will yet be added. The following is a list of those thus far recorded with the dates at which they were observed and which may be compared with those of their regular vernal period:

- Ranunculus abortivus, var. micranthus, November 28, 1875.
- Cardamine hirsuta, October 3, 1880.
- Viola pedata, var. bicolor, September 22, and December 8, 1878
- Viola striata, September 10, 1876.
- Fragaria Virginiana, September 22, 1878.
- Rubus villosus, September 22, and October 27, 1878.
- Lonicera Japonica, October 13, 1878.
- Houstonia purpurea, October 13, 1878.
- Houstonia purpurea, var. angustifolia, September 12, 1880.
- Houstonia cærulea, September 7, 1879.
- Vaccinium stamineum, October 13, 1878.
- Rhododendron nudiflorum, October 13, 1878.
- Sabbatia angularis, October 27, 1878.
- Phlox divaricata, October 16, 1873.
- Echium vulgare, October 8, 1880.
- Veronica officinalis, October 8, 1873.
- Agrostis scabra, November 12, 1876.

To this list of seventeen should perhaps be added *Stellaria pubera*, which instead of a vernal and autumnal period, has two vernal periods as described under that species in the systematic notes.

Salix longifolia has this year (1881,) flowered twice ; once in April and again in June.

Autumnal blooming, in so far as it is peculiar to this climate, may be chiefly attributed to the tolerably regular occurrence here of a hot and dry season in midsummer. This usually begins towards the end of June and ends about the middle of August. During this period, in some seasons, the ground and vegetation become parched and dried up, so that vegetal processes in many plants cease almost as completely as in the opposite season of cold. From this dormant state, the warm and often copious rains of the latter part of August revive them, as do the showers of spring, and they begin anew their regular course of changes. The frosts of October usually cut their career short before maturity is reached, but in some cases two crops of seed are produced. In addition to this, there frequently also occurs a very warm term in November, often extending far into December, and of this certain species take advantage and push forth their buds and flowers.

Albinos.

Well defined albinos have been collected of the following species

Desmodium nudiflorum.

Liatris graminifolia.

Rhododendron nudiflorum.

Vinca minor.

Mertensia Virginica.

Sabbatia angularis.

Pontederia cordata.

The green flowered variety of *Trillium sessile* is also common, and *Gonolobus obliquus* exhibits on High Island this same anomalous feature. *Carex tentaculata* having the spikes perfectly white, as if etiolated, was found June 14 of this year, (1881,) on the Eastern Branch marsh. This last phenomenon was certainly due neither to maturity or disease, but was a mere *lusus naturæ*.

Double Flowers, &c.

Thalictrum anemonoides, *Ranunculus bullosus*, *Claytonia Virginica*, and *Rubrus Canadensis*, have been found with the flowers much doubled as in cultivation.

Hydrangea arborescens occasionally has the outer circle of petals expanded as in cultivation.

Rudbeckia fulgida has been found with all its rays tubular but of the usual length.

Statistical View of the Flora.

In order to present a clear view of the general character of the vegetation of the District of Columbia and the adjacent country, I have made a somewhat careful analysis of the large groups and families, and comparison of them not only with each other, but with the same groups and families in larger areas and other local floras. The general results are presented below.

It is important to remark that in all enumerations, it is not simply the number of *species*, as at present recognized, but the number of *different plants*, (species and varieties,) that is employed. The reason for doing this is that in very many cases, well marked varieties are eventually made species, and if two plants really differ there is little probability that they will ever be merged into one species without that difference being indicated by some difference of name. The aim has therefore been to take account of the number of plants without regard to the manner in which they are named.

The whole number of vascular plants now known to this flora, as catalogued in the list appended to this paper, is 1249, and these belong to 527 different genera, or about $2\frac{1}{2}$ species to each genus. These are distributed among the several systematic series, classes, and divisions, as follows:

GROUPS.	Genera.	Species and varieties.
Polypetalæ	174	356
Gamopetalæ	169	389
Total Dichlamydeæ	343	745
Monochlamydeæ (Apetalæ)	47	124
Total Dicotyledons	390	869
Monocotyledons	112	331
Gymnospermæ (Coniferæ)	4	7
Total Phænogamia	506	1,207
Cryptogamia	21	42
Total vascular plants	527	1,249

The percentages of the total are as follows:

Polypetalæ	33	29
Gamopetalæ	32	31
Total Dichlamydeæ	65	60
Monochlamydeæ (Apetalæ)	9	10
Total Dicotyledons	74	70
Monocotyledons	21	26
Gymnospermæ (Coniferæ)	1	1
Total Phænogamia	96	97
Cryptogamia	4	3

Large Orders.

The sixteen largest orders arranged according to the number of species, are as follows:

	Genera.	Species and varieties.
1. Compositæ	53	149
2. Graminæ	43	110
3. Cyperaceæ	10	108
4. Leguminosæ	24	57
5. Rosaceæ	15	46
6. Labiataæ	23	42
7. Cruciferae	16	33
8. Scrophulariaceæ	15	32
9. Filices	16	30
10. Ranunculaceæ	7	27
11. Ericaceæ	11	26
12. Cupuliferæ	7	26
13. Orchidaceæ	12	24
14. Liliaceæ	18	24
15. Polygonaceæ	3	23
16. Umbelliferæ	17	22

The whole number of systematic orders represented in our District is 116, of which sixteen, or 14 per cent. furnish 55 per cent. of the genera and 62 per cent. of the species.

Large Genera.

The fifteen large genera arranged according to the number of plants are the following:

	Species and varieties.
1. Carex	70
2. Aster	21
3. Panicum	19
4. Solidago	18
5. Quercus	18
6. Polygonum	16
7. Desmodium	14
8. Salix	14
9. Juncus	14
10. Viola	13
11. Cyperus	12
12. Ranunculus	11
13. Eupatorium	11
14. Helianthus	10
15. Asclepias	10

Thus fifteen, or less than three per cent., of the genera furnish 271, or nearly 22 per cent. of the species.

Introduced Species.

The whole number of introduced plants enumerated in the subjoined catalogue is 193, of which 15 are supposed or known to be indigenous to other parts of the United States.* These are distributed through the several larger groups as follows:

* These are the following:

Xanthoxylum Americanum.
 Trifolium repens.
 Prunus Chicasa.
 Rosa setigera.
 Philadelphus inodorus.
 Ribes rotundifolium.
 Ribes rubrum.
 Passiflora incarnata.

Symphoricarpus racemosus.
 Symphoricarpus vulgaris.
 Catalpa bignonioides.
 Maclura aurantiaca.
 Populus grandidentata.
 Poa annua.
 Pinus Strobus.

	Old World.	United States.	Total.
Polypetalous.....	65	8	73
Gamopetalous	54	3	57
Apetalous	28	2	30
Monocotyledonous.....	31	1	32
Coniferae	--	1	1
Total.....	178	15	193

It will be seen that the introduced plants amount to 15.5 per cent. of the total flora.

The several orders to which these belong, are shown in the summary.

Shrubby Species.

Of the 342 "Forest Trees" enumerated in Sargent's preliminary catalogue of 1880, this flora embraces 85, or 24.8 per cent., of which 65 are large enough to have the dignity of timber trees. Of these 85, 25 are in the Polypetalous Division, but only 12 of this latter number are large; 9 are in the Monopetalous Division, all but 2 of which are large; 44 are in the Apetalous Division, 39 of which are large; and the remaining 7 are Coniferous, all full-sized trees.

The whole number of species which are shrubby or woody above ground is 194, which is 15.5 per cent. of the whole; they are distributed as follows:

Polypetalous.....	83
Gamopetalous.....	36
Apetalous (Monochlamydeous).....	64
Monocotyledonous (Endogenous).....	4
Gymnospermous (Coniferous).....	7
Total.....	194

For further particulars the reader can consult the Summary at the end of the catalogue.

Comparisons with other Floras.

While these facts are of great interest in affording a clear conception of the character of our flora, they do not aid us in determining in what respects it is peculiar or marks a departure from

those of other portions of the country, or from that of the country at large. To institute comparisons with other local floras would of course carry me much too far for the general purpose of this paper, but it is both more interesting and more practicable to confront a few of the above results with similar ones, drawn from a consideration of a large part of the United States. For this purpose, as not only most convenient but as least liable to embrace facts calculated to vitiate the comparisons, I have chosen that portion of the United States situated east of the Mississippi river, and for the most part well covered by *Gray's Manual of Botany* for the Northern portion and *Chapman's Flora of the Southern States* for the Southern. The plants described in these works are conveniently collected into one series by the second edition of *Mann's Catalogue*, published under the supervision of the authorities at Cambridge, in 1872. Many changes have since been made in the names, &c., and a few new species added, but these are not sufficient to affect the general conclusions to be drawn from the following comparative tables.

Comparison of Species and Varieties.

The number of species and varieties of vascular plants enumerated in the work above referred to is 4,034, of which the 1,249 of the flora of Washington, by groups, is as follows:

	Species and varieties in the		Per Cent.
	Eastern U. S.	Flora Columbiana.	
Polypetalæ -----	1,115	356	32
Gamopetalæ -----	1,314	389	30
Total Dichlamydeæ -----	2,429	745	31
Monochlamydeæ (Apetalæ) -----	349	124	36
Total Dicotyledons -----	2,778	869	31
Monocotyledons (Endogens) -----	1,034	331	32
Gymnospermæ -----	28	7	25
Total Phænogamia -----	3,840	1,207	31
Cryptogamia -----	194	42	22
Total vascular plants -----	4,034	1,249	31

Comparison of Genera.

The whole number of genera in the flora of the Eastern United States is 1065. That of the Flora Columbiana, as already stated is 527. This is over 49 per cent., a much larger proportion than was shown by a comparison of the species. A comparison of the genera by classes, gives the following results:

	Genera represented in the		Per Cent.
	Eastern U. S.	Flora Columbiana.	
Polypetalæ -----	340	174	51
Gamopetalæ -----	379	169	45
Total Dichlamydeæ -----	719	343	48
Monochlamydeæ (Apetalæ) -----	97	47	48
Total Dicotyledons -----	816	390	48
Monocotyledons -----	198	112	57
Gymnospermæ -----	12	4	33
Total Phænogamia -----	1,026	506	49
Cryptogamia -----	39	21	54
Total vascular plants -----	1,065	527	49

The percentages here range from 33 in the Gymnosperms to 57 in the Monocotyledons, averaging between 49 and 50, whereas in the similar comparisons for species they ranged from 22 in the Cryptogams to 36 in the *Monochlamydeæ*. This result was to be expected since as the groups increase, the number represented in any local flora should be proportionally larger. For example, 116 orders out of the 156 are represented here, which is upwards of 74 per cent.

Comparison of Large Orders.

It will be interesting to compare in a manner similar to the foregoing, the number of species in several of the largest orders. For this purpose we may use the same orders mentioned a few pages back as the richest in species of any belonging to this flora. The comparison may then be shown as follows:

Orders.	Eastern U. S.	Flora Col.	Per Cent.
1. Compositæ.....	497	149	30
2. Graminæ.....	297	110	37
3. Cyperacæ.....	357	108	30
4. Leguminosæ.....	208	57	27
5. Rosacæ.....	104	46	44
6. Labiatæ.....	121	42	35
7. Cruciferae.....	76	33	43
8. Scrophulariacæ.....	97	32	33
9. Filices.....	134	30	22
10. Ranunculacæ.....	80	27	34
11. Ericacæ.....	89	26	29
12. Cupuliferae.....	45	26	58
13. Orchidacæ.....	71	24	34
14. Liliacæ.....	82	24	29
15. Polygonacæ.....	56	23	41
16. Umbelliferae.....	63	22	35

This table exhibits better perhaps than any other the special characteristics of the flora. The normal percentage being about 31, we see that in all but five of these sixteen largest orders our flora is in excess of that standard, while it is richest proportionally in the *Cupuliferae*, *Rosacæ*, and *Cruciferae*, and poorest in the *Filices*, and *Leguminosæ*.

Comparison of Large Genera.

In like manner we may compare the fifteen large genera given in a preceding table.

Genera.	Eastern U. S.	Flora Col.	Per Cent.
1. Carex.....	180	70	39
2. Aster.....	63	21	33
3. Panicum.....	36	19	53
4. Solidago.....	61	18	30
5. Quercus.....	38	18	47
6. Polygonum.....	27	16	59
7. Desmodium.....	24	14	58
8. Salix.....	23	14	61
9. Juncus.....	38	14	37
10. Viola.....	24	13	54
11. Cyperus.....	41	12	29
12. Ranunculus.....	27	11	41
13. Eupatorium.....	24	11	46
14. Helianthus.....	27	10	37
15. Asclepias.....	22	10	45

This table shows that in all the large genera except *Solidago* and *Cyperus*, the District of Columbia has more than its full proportion. The genus *Salix* is the one proportionally best represented, while *Polygonum*, *Desmodium*, *Panicum* and *Viola*, each exceed 50 per cent. *Quercus*, *Eupatorium* and *Asclepias* are also well filled out.

As already remarked, it would carry us too far to undertake the systematic comparison of our flora with those of other special localities, even were the data at hand. Few local catalogues are condensed and summarized for this purpose and the labor of doing this is very great. The recently published *Flora of Essex County Massachusetts*, prepared by Mr. John Robinson, however, forms something of an exception to this, and we may directly compare the larger classes and also the orders. The following tables will give an idea of the differences between that flora and our own :

Series, Classes, and Divisions.	Number of Orders.		Number of Genera.		Number of Species and Varieties.	
	Essex County.	Washington.	Essex County.	Washington.	Essex County.	Washington.
Polypetalæ -----	42	45	155	174	360	356
Gamopetalæ -----	25	27	158	169	358	389
Total Dichlamydeæ -----	67	72	313	343	718	745
Monochlamydeæ -----	18	19	44	47	132	124
Total Dicotyledons -----	85	91	357	390	850	869
Monocotyledons -----	17	20	120	112	392	331
Gymnospermæ (Coniferæ) -----	1	1	7	4	17	7
Total Phænogamia -----	103	112	484	506	1,259	1,207
Cryptogamia -----	5	4	20	21	65	42
Total vascular plants -----	108	116	504	527	1,324	1,249

The sixteen large orders enumerated on page 89 may also be compared with profit:

Large Orders.	Number of Genera.		Number of Species and Varieties.	
	Essex County.	Washington.	Essex County.	Washington.
1. Compositæ -----	43	53	136	149
2. Gramineæ -----	50	43	128	110
3. Cyperacæ -----	9	10	120	108
4. Leguminosæ -----	17	24	39	57
5. Rosacæ -----	12	15	55	46
6. Labiatæ -----	22	23	35	42
7. Cruciferae -----	14	16	29	33
8. Scrophulariaceæ -----	14	15	29	32
9. Filices -----	13	16	40	30
10. Ranunculacæ -----	9	7	30	27
11. Ericacæ -----	18	11	37	26
12. Cupuliferæ -----	6	7	16	26
13. Orchidacæ -----	13	12	32	24
14. Liliacæ -----	18	18	27	24
15. Polygonacæ -----	3	3	27	23
16. Umbelliferæ -----	16	17	20	22

In the flora of Essex County, the orders *Umbelliferæ* (20) and *Cupuliferæ* (16) fall below the lowest of the sixteen for the flora of Washington, (*Umbelliferæ* 22,) while on the other hand the *Caryophyllacæ* (27,) *Salicacæ* (23,) and *Naiadacæ* (28,) not in the list, rise above that number. These orders in the flora of Washington are represented respectively by 19, 19, and 9 species and varieties. With reference to the last named of these orders, however, it may be remarked that the genus *Potamogeton*, which constitutes the greater part of it, has been imperfectly studied here, and will certainly be largely increased when thoroughly known.

The orders in which this flora falls below that of Essex county are: the *Gramineæ*, *Cyperacæ*, *Rosacæ*, *Filices*, *Ranunculacæ*, *Ericacæ*, *Liliacæ*, *Orchidacæ*, and *Polygonacæ*, nine in all. In the remaining seven orders there is a greater number of species here than there. It is noteworthy that our flora exceeds that of Essex county most in the *Compositæ*, *Leguminosæ*, and *Cupuliferæ*, and

next to these in the *Scrophulariaceæ*, *Labiataæ* and *Cruciferaæ*. Our comparatively poorest orders are the *Cyperaceæ*, *Rosaceæ*, *Ericaceæ* and *Filices*. Comparing in like manner the fifteen large genera enumerated on page 90 we are able to see still more definitely wherein the two floras differ.

Large Genera.	Number of Species and Varieties.	
	Essex County.	Washington.
1. <i>Carex</i>	71	70
2. <i>Aster</i>	25	21
3. <i>Panicum</i>	14	19
4. <i>Solidago</i>	19	18
5. <i>Quercus</i>	10	18
6. <i>Polygonum</i>	21	16
7. <i>Desmodium</i>	7	14
8. <i>Salix</i>	18	14
9. <i>Juncus</i>	14	14
10. <i>Viola</i>	11	13
11. <i>Cyperus</i>	11	12
12. <i>Ranunculus</i>	13	11
13. <i>Eupatorium</i>	7	11
14. <i>Helianthus</i>	5	10
15. <i>Asclepias</i>	7	10

The total number of species and varieties represented by these fifteen genera is thus considerably larger in the Washington flora (271,) than in that of Essex county, (253;) but whereas they are absolutely the largest genera here, this is not the case there. The genus *Potamogeton* numbers 23 in Mr. Robinson's Catalogue, and the genus *Scirpus* 14, while several others probably exceed ten. Those in the above list falling below ten, the lowest on the Washington list, are *Desmodium* (7,) *Eupatorium* (7,) *Asclepias* (7,) and *Helianthus* (5.) Those in which the Essex flora exceeds the Washington flora are *Carex*, *Aster*, *Solidago*, *Polygonum*, *Salix* and *Ranunculus*, though *Carex*, *Solidago* and *Cyperus* may be regarded as equal in the two floras, and *Juncus* is exactly equal. In *Quercus*, *Desmodium*, *Eupatorium*, *Helianthus* and *Asclepias*, the Essex flora

is poor, only amounting in the second and fourth named, to half the number found here.

Relative to the above comparisons in general, it may be remarked first, that the flora of Essex county, Massachusetts, is much more thoroughly and exhaustively elaborated than that of the District of Columbia, lying as it does in the immediate center of botanical activity in this country. This alone is probably sufficient to account for all the difference in the number of species in the two localities, and it will probably be ultimately found that the two floras are very nearly equal. In the second place, if it should be thought that from its intermediate location between the southern and the northern sections of the country, our flora should naturally be the more rich in species, it may be satisfactorily urged on the other hand, that while we have only an inland territory, Essex county has both an inland and a maritime territory. Could our range be extended to embrace even a small extent of sea coast, the number would thereby be very largely increased.

As a final statistical exhibit, more comprehensive in its scope, and from a different point of view, I give below a table in which our local flora is compared not only with the floras above named, but with several others in America. As these several floras not only overlap to a considerable extent, but also differ widely in the total number of plants embraced by each, it is evident a numerical comparison would convey a very imperfect idea of the variety in their essential characteristics. It is therefore necessary to reduce them to a common standard of comparison, which has been done by disregarding the actual numbers and employing only the percentage which each group compared bears to the total for each respective flora. The relations of the several groups to the total vegetation of each flora is thus brought out, and a comparison of the percentages of the same group in the different areas displays in the clearest manner possible the predominance or scantiness of the groups in each flora. Upon this must depend, in so far as botanical statistics can indicate it, the *facies* of each flora, its peculiarities and characteristics. As in previous comparisons, the table is restricted to Phenogamous and vascular Cryptogamous plants, and the same groups are employed, except that the large genera are omitted, while the number of orders is increased to the 23 largest of this flora, which is taken as the basis of comparison, and they are arranged in the order of rank with reference to it.

The several floras compared with the total number of plants embraced in each, are as follows :

1. Flora of Washington and vicinity.....	1,249
2. Flora of Essex county, Massachusetts.....	1,324
3. Flora of the State of Illinois.....	1,542
4. Flora of Northeastern United States.....	2,365
5. Flora of Southeastern United States.....	2,696
6. Flora of Eastern United States ($\doteq 4 + 5$).....	4,034
7. Plants collected by the Fortieth Parallel Survey.....	1,254
8. Plants collected by Lieut. Wheeler's Survey.....	1,535

For the flora of Illinois, (No. 3,) and also for that of the Northern United States, east of the Mississippi, (No. 4,) I have used, without verification, the figures of the *Catalogue of the Plants of Illinois*, 1876, prepared by Mr. Harry N. Patterson, as summarized in the preface. In the former case, the introduced species are included, but the varieties seem to be excluded. In the latter case, as stated by Mr. Patterson, the introduced species are excluded, as are also doubtless the varieties.

For the flora of the Southern United States, east of Mississippi, (No. 5,) which I have compiled from Dr. Chapman's *Flora of the Southern States*, indigenous species are alone taken, in order to make it conform as nearly as possible to the flora of the Northeastern United States, (No. 4.)

The plants collected by the Fortieth Parallel Survey, (No. 7,) and those collected on Lieut. Wheeler's Survey, (No. 8,) are introduced rather as a means of contrasting the Eastern with the Western portions of the continent, than as a proper part of the comparative botanical statistics of this vicinity. The former of these collections was very thoroughly and carefully made by an energetic and experienced botanist, Mr. Sereno Watson, and derives its chief value from this fact. It embraces, however, a territory having a somewhat special character from a botanical point of view, viz: in general terms, the Great Basin between the Rocky Mountains and the Sierra Nevada, and the High Plateaus and mountains immediately adjacent, (Wasatch, Uintas, Sierras,) with a restricted range north and south. The data are taken from the summary of the work prepared by Mr. Watson, and found on page XIV of the Report. The collections embraced in the Report of Lieut. Wheeler's Survey, on the other hand, were made by numerous collectors, some of them amateurs, and were scattered over a very wide extent of

Orders.	Flora of Washington and Vicinity.	Flora of Essex County, Massachusetts.	Flora of the State of Illi- nois.	Flora of the Northern United States.	Flora of the Southern United States.	Flora of the total Eastern United States.	Plants collected by the 40th Parallel Survey.	Plants collected by Lieut. Wheeler's Survey.
1. Compositæ -----	11.9	10.3	13.0	12.2	13.7	12.3	16.5	16.6
2. Gramineæ -----	8.9	9.7	7.8	7.5	7.2	7.4	5.4	7.8
3. Cyperaceæ -----	8.6	9.1	8.5	10.5	8.0	8.9	4.4	3.8
4. Leguminosæ -----	4.6	2.9	4.7	4.3	6.1	5.2	7.2	8.2
5. Rosaceæ -----	3.7	4.2	3.2	3.0	2.2	2.6	3.4	2.9
6. Labiatæ -----	3.4	2.6	2.8	2.2	2.8	3.0	0.9	2.2
7. Cruciferae -----	2.6	2.2	2.1	2.0	1.4	1.9	4.4	2.8
8. Scrophulariaceæ -----	2.6	2.2	2.7	2.3	2.5	2.4	4.5	4.8
9. Filices -----	2.4	3.0	2.3	2.4	2.1	3.3	1.0	4.3
10. Ranunculaceæ -----	2.2	2.3	2.7	2.3	1.9	2.0	3.0	2.3
11. Ericaceæ -----	2.1	2.8	0.9	2.9	2.0	2.2	1.3	0.9
12. Cupuliferæ* -----	2.1	1.8	1.4	1.5	1.3	1.4	0.4	0.9
13. Liliaceæ -----	1.9	2.0	2.1	2.4	2.1	2.0	3.0	1.5
14. Orchidaceæ -----	1.9	2.4	1.8	2.4	1.9	1.7	0.6	0.5
15. Polygonaceæ -----	1.8	2.0	1.9	1.1	1.5	1.4	4.0	3.2
16. Umbelliferæ -----	1.8	1.5	1.8	1.7	1.6	1.6	2.4	1.2
17. Caryophyllaceæ -----	1.5	2.0	1.4	1.5	1.5	1.5	2.2	1.6
18. Salicaceæ -----	1.5	1.7	1.2	0.8	0.3	0.7	0.9	0.8
19. Onagraceæ -----	0.9	1.1	1.2	1.2	1.3	1.1	2.3	2.4
20. Saxifragaceæ -----	0.7	1.0	0.8	1.5	0.9	1.1	2.1	1.4
21. Chenopodiaceæ -----	0.7	1.3	0.7	0.5	0.5	0.6	2.1	1.5
22. Naiadaceæ -----	0.7	2.1	1.2	1.2	0.4	1.0	0.7	0.3
23. Polemoniaceæ -----	0.5	0.1	0.5	0.3	0.5	0.4	3.3	1.8

* Including the Betulaceæ.

Comparisons have already been made of our local flora with that of Essex county, Massachusetts, which contains so nearly the same number of plants. In examining the percentages in the above table, these distinctions are equally manifest. In both divisions of the *Dichlamydeæ*, and also in the Dicotyledons, and the total *Phænogamia*, our flora is richer than that of Essex county, while in the *Monochlamydeæ*, the Monocotyledons, the Gymnosperms, and the Cryptogams, it falls below. In the *Compositæ*, *Leguminosæ*, *Labiata*, *Crucifera*, *Scrophulariceæ*, *Cupuliferæ*, and a few other orders it is in excess, while in the *Gramineæ*, *Cyperaceæ*, *Rosaceæ*, *Filices*, &c., the Essex flora leads.

In the comparison with the flora of the State of Illinois, one is struck by the marked similarity in the position of the groups, not-

withstanding the well known differences in the actual species. In the *Gamopetalæ*, and total *Dichlamydeæ*, as also in the *Monochlamydeæ* the difference is very slight, while in the *Polypetalæ* it disappears entirely. The Dicotyledons are therefore nearly the same, and we find this true also of the Monocotyledons, and the Gymnosperms. Whatever slight variations occur in the above named groups, they are so adjusted as nearly to balance each other, so that when we reach the total *Phænogomia*, we again have substantial unison, which of course is maintained in the *Cryptogamia*.

This harmony is less pronounced in the larger orders, the *Compositæ* being richer, and the *Gramineæ* poorer there than here. In the *Cyperaceæ*, *Leguminosæ*, *Scrophulariaceæ*, and *Filices*, the difference is not great, but in the *Rosaceæ*, *Labiataæ*, *Cruciferaæ*, and *Cupuliferaæ*, the Washington flora is decidedly in advance, and in the *Ericaceæ* it is of course in very marked contrast. In the *Orchidaceæ*, *Polygonaceæ*, *Umbelliferaæ*, *Caryophyllaceæ*, and *Polemoniaceæ*, there is substantial, or exact identity. In the *Ranunculaceæ*, *Onagraceæ*, *Naiadaceæ*, and *Liliaceæ*, besides the *Compositæ* already mentioned, the Illinois flora leads that of Washington. On the whole there is a remarkable similarity in the facies of these two floras, which may be due to their inland situation, with fluriatile areas, and similar position as to latitude. Considering, however, the marked specific peculiarities of the flora of the flat prairies of the West, we would have naturally looked for a corresponding distinctness in the larger groups and orders.

The comparisons of our flora, from this point of view, with those of the Northern and Southern States, east of the Mississippi river, and with these two combined, as represented in the next three columns, proves of the highest interest, and will repay somewhat close inspection. It has often been asked, to what extent the flora of Washington is affected by influences of a peculiarly southern character, and while it has generally been conceded that it belongs clearly to the northern section of the country, many facts, such as those previously set forth, relative to autumnal flowering and early flowering, as well as to the number of species, which exhibit more or less green foliage throughout the winter, combine to give it a decidedly southern aspect. In so far as the method of testing such questions which has been here adopted can be relied upon, this southern leaning on the part of the Washington flora is clearly exhibited in this table. In letting the eye follow columns four and

five, the differences are well marked in nearly all the groups, and in most of the large orders. These are what express statistically the essential characteristics of the northern as contrasted with the southern flora. It is also obvious that the figures in column six will, in most cases, express the mean between these two extremes. To obtain the true position of our flora, it is necessary to observe toward which of these extremes it most nearly approaches, and whether it falls on the northern or southern side of the mean established by column six. In instituting this comparison, we perceive at the outset, that in the Polypetalous division, it falls so far on the southern side as to come within four tenths of one per cent. of being identical with the flora of the Southern States. In the *Gamopetalæ*, however, it agrees quite closely with the flora of Northern States, so that in the *Dichlamydeæ* as a whole, it coincides very well with the mean for both sections. The *Monochlamydeæ* agree better with those of the Southern States and the total Dicotyledons fall largely on the southern side of the mean. The Monocotyledons also fall somewhat on the southern side, while the Gymnosperms are below the mean which here corresponds with the southern flora. This leaves the total Phænogams, occupying an intermediate position. The Cryptogams are also very nearly intermediate, though approaching the northern side.

Considering next the relations of the large orders, we find that in the *Compositæ* our flora is northern in aspect. In the *Graminææ* it is very exceptionally rich, surpassing all the larger areas and approaching that of Essex county, Massachusetts. In the *Cyperaceæ*, which are peculiarly typical for the purpose, on account of being indigenous in all the floras, it does not correspond at all, either with the northern section or with the average of both sections, but does agree very closely with the exceptionally meager representation of the southern flora. The *Leguminosæ* are here northern in aspect, the *Rosaceæ*, like the *Graminææ*, exceptionally rich, far exceeding either section, as is also the case with the *Labiataæ* and the *Cruciferaæ*. The ferns are northern in their degree of representation, as are the *Ranunculaceæ* while the *Ericaceæ* and *Scrophulariaceæ* are southern. The *Cupuliferaæ* again are anomalous and tower above all other floras. The *Liliaceæ* are southern, as are also the *Orchidaceæ*. The *Polygonaceæ* are in excess, and in so far southern in aspect, while the *Umbelliferaæ*, also in excess, denote a northern inclination. The *Caryophyllaceæ* are remarkable for

showing the same percentage in all of the four floras now under comparison. The *Salicaceæ* are largely in excess of every flora compared in the table, except that of Essex county, Massachusetts, while *Onagraceæ* and *Saxifragaceæ* both fall below the normal, the latter, however, showing a southern tendency. The *Naiadaceæ* are southern, as are also the *Polemoniaceæ*, while the *Chenopodiaceæ* are slightly in excess in their degree of representation.

Now, as this locality has been classed as northern, we should not expect to find it occupying an intermediate position, which would place it on the boundary line between the northern and the southern flora, but we should expect to find it agreeing closely with the northern flora, or at least lying midway statistically, as it does geographically, between the dividing line or medium, represented by the total eastern flora and the northern flora. So far is this from being the case, however, that we actually find it occupying a position considerably below the medium line, and between this and the line of the southern flora; a position which would be geographically represented by the latitude of Nashville or Raleigh, or even by Memphis or Chattanooga.

This result is very remarkable, and while the proofs from statistics are, perhaps, not alone to be relied upon, it serves to confirm many facts recorded which have puzzled the observers of the phenomena of the vegetable kingdom in this locality.

The results of the careful comparison of the two remaining columns need not be here summed up, as the reader will readily perceive their general import, and he will not be likely to stop with considering the relations of the local flora with those of the far West, but will probably seek for more general laws governing the vegetation of the eastern and western sections, as we have already done to some extent for the northern and southern sections.

Abundant Species.

It was Humboldt who remarked that of the three great Kingdoms of Nature, the Mineral, the Vegetable, and the Animal, it is the Vegetable which contributes most to give character to a landscape. This is very true, and it is also true, that botanists rarely take account of this fact. The latter are always interested in the relative numbers of species belonging to different Classes, Families, and Genera, rather than to the mere superficial aspect of the vege-

tation. It is, however, not the number of species, but individuals which give any particular flora its distinguishing characteristics to all but systematic botanists, and it is upon this, that in the main depends the commercial and industrial value of the plant-life of every region of the globe. It is often the omnipresence of a few, or even of a single, abundant species that stamps its peculiar character upon the landscape of a locality. This is to a far greater extent true of many other regions, especially in the far West, than it is of this; the vegetation of the rural surroundings of Washington is of a highly varied character, as much so perhaps as that of any part of the United States. And yet there are comparatively few species, which from their abundance chiefly lend character to the landscape, and really constitute the great bulk of the vegetation. The most prominent, if not actually the most numerous of these, are of course, certain trees and notably several species of oak. Probably the most abundant tree here, as in nearly all parts of the country, is *Quercus alba*, the white oak; but *Q. prinus*, the chestnut oak, *Q. coccinea*, the scarlet oak, *Q. palustris*, the swamp oak, and *Q. falcata*, the Spanish oak, are exceedingly common. The most abundant hickory is *Carya tomentosa*, the mockernut. *Liriodendron tulipifera*, the tulip-tree, often improperly called white poplar, besides being one of the commonest trees, is the true monarch of our forests, often attaining immense size. It is a truly beautiful tree whose ample foliage well warrants the recent apparently successful experiments in introducing it as a shade tree for the streets of the city. Among other common trees may be mentioned the chestnut, (*Castanea vulgaris*, Lam, var. *Americana*, A. D. C., the beech, (*Fagus ferruginea*,) the red maple, (*Acer rubrum*,) the sycamore, (*Platanus occidentalis*,) the red or river birch, (*Betula nigra*,) the white elm, (*Ulmus Americana*,) the sour gum, (*Nyssa multiflora*,) the sweet gum, (*Liquid-amber Styraciflua*,) the scrub pine, (*Pinus inops*,) the pitch pine, (*P. rigida*,) and the yellow pine, (*P. mitis*,).

Of the smaller trees, *Cornus florida*, the flowering dogwood and *Cercis Canadensis*, the red-bud or Judas tree are very abundant, and chiefly conspicuous in the spring from the profusion of their showy blossoms; all three species of sumac are common. *Hamamelis Virginica*, the witch-hazel, and *Virburnum prunifolium* the black haw abound; *Sassafras officinale*, sassafras, *Castanea pumila*,

the chinquapin and *Juniperus Virginiana*, the red cedar also belong to this class.

Of the smaller shrubby vegetation, we may safely claim as abundant *Cornus sericea*, and *C. alternifolia*, the silky, and the alternate-leaved normal *Viburnum acerifolium*, *V. dentatum*, and *V. nudum*, arrow-woods, *Gaylussacia resinosa*, the high-bush huckleberry, *Vaccinium stamineum*, the deer berry, *V. vacillans* and *V. corymbosum* the blueberries, *Leucothoe racemosa*, *Andromeda Mariana*, the stagger bush, *Kalmia latifolia*, the American laurel, or calico-bush, *Rhododendron nudiflorum*, the purple azalea flower, *Lindera Benzoin*, the spice bush.

Of vines besides three species of grape which are abundant, we have *Ampelopsis Virginiana*, the Virginian creeper or American woodbine, *Rhus toxicodendron*, the poison ivy, and *Tecoma radicans*, the trumpet vine, which give great beauty and variety to the scenery.

The most richly represented herbaceous species may be enumerated somewhat in their systematic order. Of *Polypetalæ*, may be mentioned *Ranunculus repens*, *Cimicifuga racemosa*, *Dentaria laciniata*, *Viola cucullata*, *Viola pedata*, var. *bicolor*, and *V. tricolor*, var. *arvensis*; *Stellaria pubera*, *Cerastium oblongifolium*, *Geranium maculatum*, *Impatiens pallida*, and *I. fulva*; *Desmodium nudiflorum*, *D. acuminatum*, and *D. Dillenii*; *Vicia Caroliniana*, *Potentilla Canadensis*, *Geum album*, *Saxifraga Virginiana*, *Oenothera fruticosa*, and *Thaspium barbinode*. In the *Gamopetalæ* before *Compositæ*, we have *Galium aparine*, *Mitchella repens*, *Houstonia purpurea*, and *H. cærulea*. In the *Compositæ*, the most conspicuous are; *Vernonia noveboracense*, *Eupatorium purpureum*, *Liatris graminifolia*, *Aster patens*, *A. ericoides*, *A. simplex* and *A. miser*, *Solidago nemoralis*, *S. Canadensis*, *S. altissima*, and *S. ulmifolia*; *Chrysopsis Mariana*, *Ambrosia trifida*, and *A. artemisiæfolia*, (these behaving like introduced weeds;) *Helianthus divaricatus*, *Actinomeris squarrosa*, *Rudbeckia laciniata*, and *R. fulgida*; *Coreopsis verticillata*, *Bidens cernua*, *Verbesina Siegesbeckia*, *Gnaphalium polycephalum*, *Antennaria plantaginifolia*, *Hieracium venosum*, and *H. Gronovii*; *Nabalus albus*, and *N. Traseri*, *Lactuca Canadensis*.

The remaining *Gamopetalæ* furnish as abundant species: *Lobelia spicata*, *Chimaphila umbellata*, and *C. maculata*; *Veronica officinalis*, and *V. Virginica*, *Gerardia flava*, *Verbena hastata*, and *V. urticifolia*; *Pycnanthemum incanum*, and *P. linifolium*, *Collinsonia Canadensis*,

Salvia lyrata, *Monarda fistulosa*, and *M. punctata*; *Nepeta glechoma*, *Brunella vulgaris*, *Mertensia Virginica*, *Flox paniculata*, and *P. divaricata*; *Solanum Carolinense*, and *Asclepias cornuti*.

Of herbaceous *Monochlamydeæ* may be named *Polygonum Virginianum*, *P. sagittatum*, and *P. dumetorum*; *Laportea Canadensis*, *Pilea pumila*, and *Bœmhria cylindrica*.

The *Monocotyledons* give us *Arisæma triphyllum*, the Indian turnip, *Sagittaria variabilis*, *Aplectrum hyemale*, *Erythronium Americanum*, *Luzula campestris*, *Juncus effusus*, *Juncus marginatus*, and *Juncus tenuis*, *Pontederia cordata*.

Of the *Cyperi*, *C. phymatodes*, *C. strigosus* and *C. ovularis* are the most common. *Eleocharis obtusa* and *E. palustris*; *Scirpus pungens*, *S. atrovirens*, *S. polyphyllus*, and *S. eriophorum*, are very conspicuous. Of *Carices*, *C. crinata*, *C. intumescens*, the various forms of *C. laxiflora*, *C. platyphylla*, *C. rosea*, *C. scoparia*, *C. squarrosa*, *C. straminea*, *C. stricta*, *C. tentaculata*, *C. virescens* and *C. vulpinoides*, are the most obtrusive. In the *Gramineæ*, those which most uniformly strike the eye are *Agrostis scabra*, *Muhlenbergia Mexicana*, and *M. sylvatica*, *Tricuspis seslerioides*, *Eatonia Pennsylvanica*, *Poa pratensis*, *Poa sylvestris*, and *P. brevifolia*,; *Eragrostis pectenacea*, *Festuca nutans*, *Bromus ciliatus*, *Elymus Virginicus*, *Danthonia spicata*, *Anthoxanthum odoratum*, *Panicum virgatum*, *P. latifolium*, *P. dichotomum*, (with a multitude of forms,) and *P. depauperatum*; *Andropogon Virginicus*, and *A. scoparius*.

Of ferns *Polypodium vulgare*, *Pteris aquilina*, *Adiantum pedatum*, *Asplenium ebeneum*, and *A. Filix-fœmina*; *Phegopteris hexagonoptera*, *Aspidium acrostichoides*, *A. marginale* and *A. Noveboracense*; *Osmunda regalis*, *O. Claytoniana*, and *O. cinnamomea*, are the most constantly met with.

Lycopodium lucidulum is quite common, and *L. complanatum* is very abundant in certain localities.

Besides the above, which are all indigenous to our flora, there are many introduced species in the vicinity of the city, and of cultivation everywhere which manifest here as elsewhere, their characteristic tendency to crowd out other plants and monopolize the soil.

Such are the most general features which the traveler accustomed to observe the vegetable characteristics of localities visited, may expect to see when he pays his respects to the Potomac valley. To

some even this imperfect description might furnish a fair idea of our vegetable scenery without actually seeing it.

Classification Adopted.

In endeavoring to conform to the latest authoritative decisions relative to the most natural system of classification, I have followed, with one exception, the arrangement of the *Genera Plantarum* of Bentham and Hooker so far as this goes, and the accepted authorities of Europe and America for the remainder. For the *Gamopetalæ* after *Compositæ*, however, covered by Prof. Gray's *Synoptical Flora* of *North America*, I have followed that work which is substantially in harmony with the *Genera Plantarum*. In the arrangement of the orders, too, for the *Polypetalæ*, Mr. Sereno Watson's *Botanical Index* has in all cases been conformed to, as also not materially deviating from the order adopted by Bentham and Hooker. In the genera there are numerous discrepancies between the works last named, and in the majority of these cases the American authorities have been followed. For example, Bentham and Hooker have thrown *Dentaria* into *Cardamine*, *Elodes* into *Hypericum*, and *Ampelopsis* into *Vitis*, and *Pastinaca* and *Archemora* into *Peucedanum*. The change of *Spergularia* to *Lepigonum* is adopted, as well as a few alterations in orthography where the etymology seemed to demand them, as *Pyrus* to *Pirus* and *Zanthoxylum* to *Xanthoxylum*. I have also declined to follow Bentham and Hooker in the changes which they have made in the terminations of many ordinal names. The termination *aceæ* is, doubtless quite arbitrary in many cases, and, perhaps, cannot be defended on etymological grounds but as a strictly ordinal ending it has done good service in placing botanical nomenclature on a more scientific footing. It is also true that the old system does not always employ it, as in some of the largest orders, *e. g.* *Cruciferae*, *Leguminosæ*, *Compositæ*, *Labiatae*; but whatever changes are made should rather be in the direction of making it universal than less general. Bentham and Hooker do not adopt a universal termination, neither do they abolish the prevailing one, and they retain it in the majority of cases; but in certain cases, for which they doubtless have special reasons, they substitute a different one, and one which is often far less euphonious. The following are the orders represented in this catalogue in which the ter-

mination *aceæ* is retained by American and altered by English authorities.

<i>American.</i>	<i>English.</i>
Berberidaceæ.	Berberidææ.
Cistaceæ.	Cistineæ.
Violaceæ.	Violarieæ.
Polygalaceæ.	Polygaleæ.
Caryophyllaceæ.	Caryophylleæ.
Portulacaceæ.	Portulacææ.
Hypericaceæ.	Hypericineæ.
Celastraceæ.	Celastrineæ.
Vitaceæ.	Ampelidææ.
Saxifragaceæ.	Saxifrageæ.
Hamamelaceæ.	Hamamelidææ.
Lythraceæ.	Lythrarieæ.
Onagraceæ.	Onagrarieæ.
Passifloraceæ.	Passifloreæ.
Cactaceæ.	Casteæ.
Valerianaceæ.	Valerianeæ.
Asclepiadaceæ.	Asclepiadeæ.
Gentianaceæ.	Gentianeæ.
Borraginaceæ.	Borragineæ.
Scrophulariaceæ.	Scrophularineæ.
Lentibulaceæ.	Lentibulariceæ.
Plantaginaceæ.	Plantagineæ.
Nyctaginaceæ.	Nyctagineæ.
Lauraceæ.	Laurineæ.
Juglandaceæ.	Juglandeæ.
Salicaceæ.	Salicineæ.
Ceratophyllaceæ.	Ceratophylleæ.

On the other hand, the British authorities are followed in uniting the *Saururaceæ* with the *Piperaceæ*, and also in placing the *Paronychieæ*, reduced to a sub-order under the *Illecebraceæ*; but from the certain relationship of this order with the *Caryophyllaceæ*, it is deemed unnatural to separate these two orders by putting the former into the *Monochlamydeous* division. [See American Naturalist, November, 1878, p. 726.] On the same ground of apparently close relationship, I have followed Bentham and Hooker in abolishing the *Callitrichaceæ*, and placing *Callitriche* in the *Haloragaceæ*. On the other hand I have followed Gray in retaining the *Lobeliaceæ*, as also in keeping the *Ericaceæ* intact, and not slicing off the *Vacciniaceæ* from one end, and the *Monotropeæ* from the other, as is done in the *Genera Plantarum*.

In the *Gamopetalæ*, before and including *Compositæ*, in the *Monochlamydeæ*, and throughout the *Monocotyledons*, serious difficulties occur in consequence of a want of recent systematic works from the American point of view. In nearly all cases the names as well as the arrangement of Gray's Manual, 5th edition, have here been adopted. I have, however, been able to avail myself of a number of recent revisions of genera made by Gray, Watson, and Engelman* and published in various forms, chiefly in the Proceedings of the American Academy of Arts and Sciences. I have also derived many useful hints from the *Flora of California*, from the botanical reports of the various Western Surveys, from Sargent's Catalogue of the Forest Trees of North America, and from the *Flora of Essex county, Massachusetts*.

Mr. M. S. Bebb, of Rockford, Illinois, has shown great kindness not only in determining all the uncertain *Salices*, but in generously drawing up a list of them in the order of their nearest natural relationship, which is followed implicitly in the catalogue.

For the Ferns, the magnificent work of Prof. Eaton has furnished everything that could be desired, and is unswervingly adhered to.

The following genera in the *Compositæ* have been changed by Bentham and Hooker, but the new names cannot be adopted until the species have been worked up by American botanists. The old ones are therefore retained with a simple indication of the recent disposition.

Maruta has been made *Anthemis*.

Leucanthemum has been made *Chrysanthemum*.

Cacalia has been made *Senecio*.

Lappa has been made *Arctium*.

Cynthia has been made *Krigia*.

Mulgedium has been made *Lactuca*.

Nabalus has been made *Prenanthes*.

* While I have gladly adopted the arrangement of the species of *Quercus* decided upon by Dr. Engelman after so careful a study, I cannot do so without recording a gentle protest against the position to which he assigns *Q. palustris*. viz: between *Q. falcata*, and *Q. nigra*, and far removed from *Q. rubra*. Not only the shallow, finely scaled cup, but especially its light colored buds and thin early leaves, as also a special *facies* belonging to its aments and foliage ally this species with *Q. rubra*, and distinguish these two species as a group from all others found in this flora.

Several of these cases are a return to the older names, and whether they will be adopted by American authorities it is impossible to say.

It remains to consider the one deviation above referred to from the prevailing system of botanical classification, which it has been thought proper to make in the subjoined list of plants. This consists in placing the *Gymnosperms*, here represented only by the single order *Coniferæ*, after the *Monocotyledons* and next to the *Cryptogams*.

It is not the proper place here to state the already well known grounds upon which this position of the *Gymnosperms* has been defended. [See *American Naturalist*, June, 1878, pp. 359 to 378.] It is sufficient to point out that the correctness of this arrangement was recognized by Adrien de Jussieu, and has been repeatedly maintained by later botanists of eminence. The object in adopting it here, however, is not simply because it seems fully justified by the present known characters of plants, for consistently to do this would also require that the *Polypetalæ* be placed before the *Monochlamydeæ* (in the descending series,) and that numerous other changes be made. So wide a departure from the existing system would seriously detract from the convenience of the work as a practical aid to the local botanist, and aside from the labyrinth of nice and critical points into which it must inevitably lead, it would not be advisable in the present state of botanical literature. But as the position of the *Gymnosperms* is the most glaringly inconsistent of all the defects of the present so-called Natural System, and as the *Coniferæ* are represented here by only four genera and seven species, it is evident that no serious objection could arise on the ground of inconvenience, while at the same time it may serve some useful purpose in directing the minds of botanists who may look over the work to the obvious rationality of this classification, and contribute its mite towards awakening them to the recognition of a truth which, I cannot doubt, must sooner or later find expression in all accepted versions of the true order of nature with respect to the vegetable kingdom.

Common Names.

I am well aware that in recent times it has become more and more the practice among botanists to eschew all common or popular names of plants. This sentiment I share to a great extent and will

therefore remark at the outset that the best common name for a plant is always its systematic name, and this should be made a substitute for other popular names wherever and whenever it can be done. In most cases the names of the genera can be employed with entire convenience and safety; and in many cases they are to be defended on the ground of euphony. How much better, for example, the name *Brunella* sounds than either Self-heal, or Heal-all, both of which latter, so far as their meaning goes, express an utter falsehood. Some works professing to give common names frequently repeat the generic name, as such. This has seemed to me both unnecessary and calculated to mislead. It is not done where other accepted common names exist, and thus the implication is that in such cases it is incorrect to use the Latin name. Again it is only done for the commoner species, leaving it to be inferred that there is no popular way of designating the rarer ones. The plan here followed is to regard the genus as the best name to use in all cases, and as *ex officio* the proper common name of every plant, and, therefore, not in need of being repeated in different type as such in any case. But in addition it has been deemed best to give such appropriate or well established common names as can be found. Some scientific men seem disposed to forget that it is the things rather than the names that constitute the objects of scientific study. There is a vast amount of true scientific observation made by mere school-girls and rustics, who do not know the name of the branch of science they are pursuing. A knowledge of a plant by whatever name or by no name at all is scientific knowledge, and the devotees of science should care less for the means than the end which they have in view. Individuals differ in their constitution and character. The sound or sight of a Latin word is sometimes sufficient, in consequence of ineradicable, constitutional or acquired idiosyncrasies, to repel a promising young man, or woman, from the pursuit of a science for which genuine aptitude and fondness exist. For such and other classes, common English names have a true scientific value. The object should be to inspire a love for plants in all who can be made to take an interest in them, and to this end to render the science of Botany attractive by every legitimate means available. In so far, therefore, as English names of plants can be made conducive to this end, they should be employed. Their inadequacy to the true needs of the science in its later stages

cannot fail to impress itself upon all who pursue it to any considerable extent.

Finally common names are not wholly without their scientific uses. A few of them have proved more persistent than any of the systematic names, as I have had occasion to observe in examining the *Prodromus Floræ Columbianæ* of 1838, in which difficult work, I must confess, they frequently rendered me efficient aid in determining the identity of plants, which the Latin names used did not reveal.

In appending common names to the plants of this vicinity *The Native Wild Flowers and Ferns of the United States*, by Prof. Thomas Meehan, has been followed in most cases, so far as this work goes, but this of course embraces but a fraction of the entire flora. Most of the remaining names are taken from Gray's Manual of Botany, and from his Synoptical Flora of the United States. In many cases some of the names given which do not seem appropriate are omitted, and in a few cases those given have been slightly changed. A small number of local names given, not found in any book, but in themselves very expressive, have been given, as "curly head" for *Clematis ochroleuca*, &c.; and in a few other cases, names have been assigned to abundant species on the analogy of those given for allied genera or species.

Concluding Remarks.

The foregoing remarks on the value of common names naturally suggest a few general reflections with which our introduction will conclude.

The popularization of science is now a leading theme of scientific men. To accomplish this, certain branches of science must first become a part of liberal culture. The pursuit of fashion, which is usually regarded as productive solely of evil, may be made an agency of good. If it could become as much of a disgrace to be found ignorant of the flora or fauna of one's native place as it now is to be found ignorant of the rules of etiquette or the contents of the last new novel, devotees of Botany and natural history would immediately become legion, and the woods and fields would be incessantly scoured for specimens and objects of scientific interest. It should be the acknowledged work of educationalists to make science fashionable and call to their aid these powerful social sentiments in demanding the recognition of its legitimate claims.

Of all the natural sciences, that of Botany is the most easily converted into a branch of culture. Its objects appeal directly to the highest esthetic faculties. It naturally allies itself with the arts of drawing, painting, and sketching, and the deeper the insight into its mysteries the stronger does it appeal to the imagination. Its pursuit, besides being the best possible restorer of lost, and preserver of good health, is a perpetual source of the purest and liveliest pleasure. The companionship of plants, which those who do not know them cannot have, is scarcely second to that of human friends. The botanist is never alone. Wherever he goes he is surrounded by these interesting companions. A source of pure delight even where they are familiarly known to him, unlike those of his own kind, they grow in interest as their acquaintance grows less intimate, and in all his travels they multiply immensely his resources of enjoyment.

The man of science wonders what the unscientific can find to render travel a pleasure, and it must be confessed that a great many tourists of both sexes go at the behest of fashion, and care little more for nature when crossing the Alps than did Julius Cæsar, who could only complain of the bad roads and while away the hours in writing his grammatical treatise, *De Analogia*. While all forms of natural science, so far from paralyzing the esthetic faculties, tend powerfully to quicken them, that of Natural History and especially of Botany awakens such an interest in Nature and her beautiful objects, that those who have once tasted pleasure of this class may well consider other pleasures insipid.

But notwithstanding these attractions which Botany possesses above other sciences, there exists among a small class of scientific men a disposition to look down upon it as lacking scientific dignity, as mere pastime for school-girls or fanatical specialists. This feeling is most obvious among zoölogists, some of whom affect to disdain the more humble forms of life and the simplicity of the tame and stationary plant.

This sentiment, though now happily rare, is natural and really constitutes what there is left of that proud spirit with which man has ever approached the problems of Nature. His first studies disdained even so complicated an organism as man himself, and spent themselves in the pursuit of spiritual entities wholly beyond the sphere of science. Later he deigned to study *mind* detached from body and from matter, still later he attacked some of the

higher manifestations of *life*. Ethics came next, and social organizations; then anthropological questions were opened, and next those of physiology and anatomy, and at last comparative anatomy and structural zoölogy. Phytology brought up the rear and was long confined to the most superficial aspects. It is only in recent times that plants and all the other lowly organisms have begun to receive proper attention, and only since this has been done has there been made any real progress in solving the problem of Biology.

It is a paradox in science that its most complicated forms must first be studied and its simplest forms last, while only through an acquaintance with the latter can a fundamental knowledge be obtained. The history of biological science furnishes many striking illustrations of this truth, the most interesting of which is perhaps to be found in the labors of the two great French savants, Cuvier and Lamarck. The former spent his life and powers in the study of vertebrate zoölogy amid the most complex living organisms. The latter devoted his energies to Botany and to Invertebrate Zoölogy, including the protozoan and protistan kingdoms. The former founded his great theory of types, and his cosmology of successive annihilation and reconstructions of the life of the globe. The latter promulgated his theory of unbroken descent with modification. The conclusions of the former were accepted in his day, and are rejected in ours, those of the latter were rejected in his own lifetime, but now form the very warp of scientific opinion.

Let no botanist, therefore, or person contemplating the study of Botany be deterred by the humble nature of the objects he would cultivate. The humblest flower or coarsest weed may contain lessons of wisdom more profound than can be drawn from the most complicated conditions of life or of mind.

The city of Washington is becoming more and more a center, not only of scientific learning and research, but also of art and every form of liberal culture. Already the public schools have reached out and taken Botany into their curriculum, and we have seen that as a field for the pursuit of this branch of science the environs of the National Capital are in a high degree adapted. Science and culture must go hand in hand. Culture must become more scientific, and science more cultured. Botany has an important part to perform in this work of reconciliation, and there is no good reason why Washington may not become one of the foci from

which these influences are to radiate. It has been such reflections as these, aside from the practical needs for such a work, that have encouraged me to persevere in this humble, indeed, but not the less laborious task, and if it shall be found useful to however slight a degree, in promoting these worthy objects, no regrets will arise at having undertaken it.

SUMMARY.

No.	ORDERS.	Genera.	Species.	Varieties.	Species and Varieties.	Introduced Plants.	Woody Plants.	Trees.
1	Ranunculaceæ	7	23	4	27	3	...	...
2	Magnoliaceæ	2	2	...	2	...	2	2
3	Anonaceæ	1	1	...	1	...	1	1
4	Menispermaceæ	1	1	...	1	...	1	...
5	Berberidaceæ	4	4	...	4	1	1	...
6	Nymphaeaceæ	3	3	...	3	...	...	...
7	Sarraceniaceæ	1	1	...	1	...	...	...
8	Papaveraceæ	3	3	...	3	2	...	...
9	Fumariaceæ	3	3	...	3	1	...	...
10	Cruciferae	16	32	1	33	15	...	...
11	Cistaceæ	2	2	...	2	...	...	...
12	Violaceæ	2	9	5	14	...	...	...
13	Polygalaceæ	1	7	...	7	...	...	...
14	Caryophyllaceæ	9	19	...	19	8	...	...
15	Illecebraceæ	2	2	1	3	...	...	...
16	Portulacaceæ	2	2	...	2	1	...	...
17	Hypericaceæ	3	9	...	9	1	1	...
18	Malvaceæ	4	7	...	7	5	...	...
19	Tiliaceæ	1	1	...	1	...	1	1
20	Linaceæ	1	3	...	3	1	...	...
21	Geraniaceæ	4	9	...	9	3	...	...
22	Rutaceæ	2	2	...	2	1	2	...
23	Ilicineæ	1	4	...	4	...	4	1
24	Celastraceæ	2	3	1	4	...	4	...
25	Rhamnaceæ	1	2	...	2	...	2	...
26	Vitaceæ	2	6	...	6	...	6	...
27	Sapindaceæ	3	5	...	5	...	5	4
28	Anacardiaceæ	1	6	...	6	...	6	1
29	Leguminosæ	24	55	2	57	13	4	3
30	Rosaceæ	15	43	3	46	12	30	8
31	Saxifragaceæ	8	9	...	9	3	5	...
32	Crassulaceæ	2	3	...	3	...	...	...
33	Droseraceæ	1	1	...	1	...	...	...
34	Hamamelaceæ	2	2	...	2	...	2	1
35	Haloragææ	3	3	...	3	...	...	...
36	Melastomaceæ	1	1	...	1	...	...	...
37	Lythraceæ	4	4	...	4	...	...	...
38	Onagraceæ	6	10	1	11	...	...	...
39	Passifloraceæ	1	2	...	2	1	...	...

SUMMARY.—*Continued.*

No.	ORDERS.	Genera.	Species.	Varieties.	Species and Varieties.	Introduced Plants.	Woody Plants.	Trees.
40	Cucurbitaceæ	1	1	...	1	...	...	...
41	Cactaceæ	1	1	...	1	...	...	...
42	Ficoideæ	1	1	...	1	...	...	...
43	Umbelliferae	17	22	...	22	2	...	...
44	Araliaceæ	1	4	...	4	...	1	1
45	Cornaceæ	2	5	...	5	...	5	2
46	Caprifoliaceæ	5	12	...	12	3	10	1
47	Rubiaceæ	5	12	1	13	...	1	...
48	Valerianaceæ	2	4	...	4	1	...	...
49	Dipsaceæ	1	1	...	1	1	...	...
50	Compositæ	53	138	II	149	17	1	...
51	Lobeliaceæ	1	5	...	5	...	...	...
52	Campanulaceæ	2	2	...	2	...	...	...
53	Ericaceæ	11	24	2	26	...	17	2
54	Primulaceæ	5	8	2	10	2	...	...
55	Ebenaceæ	1	1	...	1	...	1	1
56	Oleaceæ	2	4	...	4	...	4	4
57	Apocynaceæ	2	2	1	3	1	...	...
58	Asclepiadaceæ	4	13	1	14	...	...	...
59	Gentianaceæ	4	6	...	6	...	...	...
60	Polemoniaceæ	2	6	...	6	...	...	...
61	Hydrophyllaceæ	3	4	...	4	...	...	...
62	Borraginaceæ	7	12	...	12	3	...	...
63	Convolvulaceæ	3	11	...	11	4	...	...
64	Solanaceæ	5	8	...	8	5	...	...
65	Scrophulariaceæ	15	32	...	32	5	...	...
66	Orobanchaceæ	4	4	...	4	1	...	...
67	Lentibulaceæ	1	2	...	2	...	...	...
68	Bignoniaceæ	2	2	...	2	1	2	1
69	Acanthaceæ	2	3	1	4	...	...	...
70	Verbenaceæ	3	6	...	6	1	...	...
71	Labiatae	23	41	1	42	10	...	...
72	Plantaginaceæ	1	5	1	6	2	...	...
73	Amarantaceæ	2	5	...	5	4	...	...
74	Chenopodiaceæ	3	7	2	9	7	...	...
75	Phytolaccaceæ	1	1	...	1	...	...	...
76	Polygonaceæ	3	21	2	23	7	...	...
77	Podostemaceæ	1	1	...	1	...	...	...
78	Aristolochiaceæ	2	2	...	2	...	...	...
79	Piperaceæ	1	1	...	1	...	...	...
80	Lauraceæ	2	2	...	2	...	2	1
81	Thymelaceæ	1	1	...	1	...	1	...
82	Santalaceæ	1	1	...	1	...	...	...
83	Loranthaceæ	1	1	...	1	...	1	...
84	Euphorbiaceæ	4	9	...	9	1	...	...
85	Urticaceæ	11	13	...	13	4	6	6
86	Platanaceæ	1	1	...	1	...	1	1
87	Juglandaceæ	2	7	...	7	...	7	7
88	Myricaceæ	1	1	...	1	...	1	...

BULLETIN OF THE
SUMMARY.—*Continued.*

No.	ORDERS.	Genera.	Species.	Varieties.	Species and Varieties.	Introduced Plants.	Woody Plants.	Trees.
89	Cupuliferæ -----	7	25	1	26	...	26	23
90	Salicaceæ -----	2	14	5	19	7	19	6
91	Ceratophyllaceæ -----	1	1	...	1	...	...	...
92	Araceæ -----	5	6	...	6	...	...	...
93	Lemnaceæ -----	1	1	...	1	...	...	...
94	Typhaceæ -----	2	3	1	4	...	...	...
95	Naiadaceæ -----	2	9	...	9	...	...	...
96	Alismaceæ -----	2	3	2	5	...	...	...
97	Hydrocharidaceæ -----	2	2	...	2	...	...	...
98	Orchidaceæ -----	12	23	1	24	...	...	...
99	Amarylloidaceæ -----	1	1	...	1	...	...	...
100	Haemodoraceæ -----	1	1	...	1	...	...	...
101	Iridaceæ -----	2	6	...	6	1	...	...
102	Dioscoreaceæ -----	1	1	...	1	...	...	...
103	Smilaceæ -----	1	6	...	6	...	4	...
104	Liliaceæ -----	18	24	...	24	5	...	...
105	Juncaceæ -----	2	8	7	15	...	...	...
106	Pontederiaceæ -----	3	3	...	3	...	...	...
107	Commelynaceæ -----	2	3	...	3	...	...	...
108	Xyridaceæ -----	1	1	...	1	...	...	...
109	Eriocaulonaceæ -----	1	1	...	1	...	...	...
110	Cyperaceæ -----	10	94	14	108	...	...	...
111	Gramineæ -----	43	104	6	110	26	...	...
112	Coniferæ -----	4	7	...	7	1	7	7
113	Equisetaceæ -----	1	2	...	2	...	...	...
114	Filices -----	16	29	1	30	...	...	...
115	Ophioglossaceæ -----	2	2	2	4	...	...	...
116	Lycopodiaceæ -----	2	5	1	6	...	...	...
117	Musci -----	42	98	...	98	...	...	...
118	Hepaticæ -----	23	29	...	29	...	...	...
119	Characeæ -----	2	4	...	4	...	...	...

RECAPITULATION.

Groups.	Orders.	Genera.	Species.	Varieties.	Species and Varieties.	Introduced Plants.	Woody Plants.	Trees.
Polypetalæ -----	45	174	338	18	356	73	83	25
Gamopetalæ -----	27	169	368	21	389	57	36	9
Dichlamydeæ ----	72	343	706	39	745	130	119	34
Monochlamydeæ ----	19	47	114	10	124	30	64	44
Dicotyledones ----	91	390	820	49	869	160	183	78
Monocotyledones ----	20	112	300	31	331	32	4	----
Gymnospermæ -----	1	4	7	----	7	1	7	7
Phænogamia -----	112	506	1,127	89	1,207	193	194	85
Vascular Cryptogamia.	4	21	38	4	42	----	----	----
Vascular Plants --	116	527	1,165	84	1,249	193	194	85
Cellular Cryptogamia--	3	67	131	----	131	----	----	----
Total Flora-----	119	594	1,296	84	1,380	193	194	85

On this communication, Mr C. A. WHITE remarked that he hoped Mr. Ward would be able to furnish some further information concerning the influence exerted upon a flora by the character of the country rocks. It is well known that the constitution of the strata, influencing as it does the character of the soils which cover them, had a further effect upon the native plants growing above them. Thus the granite localities of the east were more favorable to the growth of certain genera, for example, the Ericaceæ than the magnesian limestones of the Mississippi valley. He hoped that Mr. Ward might be able to ascertain how far these influences affected other families of plants.

Mr. POWELL inquired what were the characters or character of plants that had apparently disappeared from the local flora in the comparison of the field results of the present time with those obtained forty or fifty years ago.

Mr. WARD replied that the missing species in the present lists were not confined to any particular family, but were diffused considerably among the several classes.

The Society then adjourned.

193D. MEETING.

FEBRUARY 5TH, 1881.

Vice President WELLING in the Chair. *

Thirty-eight members present.

The minutes of the last meeting were read and adopted.

A communication was then read by Mr. C. E. DUTTON, on

THE SCENERY OF THE GRAND CANON DISTRICT.

The communication was reserved by the author.

Remarks upon this communication were made by Mr. J. W. POWELL, at the conclusion of which, the Society adjourned.

194TH MEETING.

FEBRUARY 19TH, 1881.

Vice President TAYLOR in the Chair.

Thirty-one members present.

The minutes of the last meeting were read and adopted.

The President announced to the Society the death of Dr. GEORGE A. OTIS. It was moved and carried, that a committee be appointed to prepare suitable resolutions for the action of the Society, relative to the death of Dr. OTIS, and the Chair appointed a committee consisting of Messrs. Antisell, Billings, and Mew.

The first communication for the evening was by Mr. J. E. TODD, of Iowa who had been invited by the General Committee to read a communication on the

QUARTERNARY DEPOSITS OF WESTERN IOWA AND EASTERN
NEBRASKA.

Mr. TODD gave first an account of the three members which compose the Quarternary deposits of the regions in questions. The lowest is in Iowa, and is the boulder-clay consisting of the hard compact clay usually occurring in this formation, with its included rocky glaciated fragments. In central and western Nebraska this clay is wanting. Upon it rests the red clay, a formation of varying thickness, but usually quite thin, rarely exceeding 20 feet. Upon this rests the *loess* which constitutes a subject of special interest. One peculiarity of it is found in the fact, that it overlies the inequalities of the country which existed prior to its disposition; being

found upon the old hill tops and slopes, as well as in the valley bottoms, and exhibiting a general "unconformity by erosion." It is composed of exceedingly fine matter without any fragments of rock of notable size, such as pebbles or stones. It contains, however, bands of calcareous concretions in lines which are usually horizontal, and these concretions are often elongated with their longer dimensions vertical. It also holds those calcareous fibres which Richthofen observed in the *loess* deposits of China, and which he believed to be casts of roots of plants. Another interesting occurrence is that of charcoal, which is found in several places in the midst of the deposits in thin bands. The fossils of the loess are the shells of geophilous mollusca.

Mr. TODD held the view that the loess is a post-pliocene lacustrine deposit, and that the region in discussion was in post-glacial time covered with a very large fresh-water lake.

Prof. T. C. CHAMBERLAIN, of Wisconsin, being present, and invited to take part in the discussion, remarked that while Mr. Todd had presented in a very able and clear manner, the reasons for attributing the loess to the deposit of silt in a lake bottom, he was of opinion that the objections to the acceptance of that view were very great. If such a lake existed over the region in question during quarternary time, it must have been of immense extent. According to the observations of Dr. C. A. White, these deposits extend to the borders of the region which drains immediately into the Mississippi river in Iowa, and they are found nearly as far west as the Rocky Mountains. Their north and south extensions are not accurately known, but they are believed to be very great. Independently of these deposits no evidences of such a lake are now known. Its boundaries are not marked by any known barriers on the east where the configuration of the country is now such that no barriers could have existed, unless the region which they should have occupied has undergone remarkable changes of which the nature cannot be specified, and of which no traces exist. To produce such a lake basin very great depressions would be necessary, and there is no evidence known to him which warrants a belief in a former depressed condition of that region sufficient to account for it. Further research may indeed relieve us of some of these difficulties or all of them, but at present they are very great. Prof. Chamberlain could not but commend, however, the earnest and scientific spirit in which Mr. Todd had pursued his valuable investigations.

Mr. O. T. MASON inquired whether the occurrences of charcoal were frequent and bore evidence of human agency.

Mr. TODD replied that charcoal was often met with, and suggested as a possible, though not probable, explanation, that the fragments may have come from some of the recent volcanic regions of the west.

Mr. C. E. DUTTON suggested that there would be little difficulty in finding a natural cause for the occurrence of charcoal, if the surface had been above water at the time it was deposited. There can be little doubt that fires are frequently started in the woods and on the plains of the west by lightning, and it is not at all incredible that they may sometimes arise from spontaneous ignition. Many of the frequent fires in the western mountains occur under circumstances which render it incredible that human agency was involved.

Mr. C. A. WHITE spoke of the great areas over which loess deposits are found. They occur not only in the upper Mississippi valley, but also in the regions of the lower Mississippi. They also occupy a great range of altitudes, some being only a few hundred feet above the level of the sea, others several thousand feet above it. They all seem to be of similar character and constitution. The absence of any barriers is one powerful argument against the existence of a lake, and the great changes of level which would be demanded to establish this hypothesis is another.

The next communication was read by Mr. C. E. DUTTON, on

THE VERMILION CLIFFS AND VALLEY OF THE VIRGEN,
IN SOUTHERN UTAH.

The paper was reserved by the author.

At its conclusion the Society adjourned.

195TH MEETING.

MARCH 5TH, 1881.

Vice-President TAYLOR in the Chair.

Twenty-two members present.

The minutes of the last meeting were read and adopted.

The Chair announced the election of Mr. Peter Winfield Lauer to membership in the Society.

The first communication was by Mr. THEODORE GILL on the
PRINCIPLES OF MORPHOLOGY.

Mr. Gill's paper may be found substantially in Johnson's Encyclopædia, under the title Morphology, which article was written by him.

The second communication was by Mr. MARCUS BAKER on the
BOUNDARY LINE BETWEEN ALASKA AND SIBERIA.

The present boundaries of the territory of Alaska were defined in the treaty of March 30, 1867, whereby Russian America was ceded to the United States. In that treaty the western boundary, or rather so much of it as is here considered, was defined as follows:

"The western limit, within which the territories and dominion conveyed are contained, passes through a point in Behring's Straits on the parallel of sixty-five degrees thirty minutes north latitude, at its intersection by the meridian which passes midway between the island of Krusenstern or Ignalook, and the island of Ratmanoff or Noonarbook, and proceeds due north without limitation into the same Frozen Ocean."

The longitude of this meridian was very properly left out of the treaty on account of its uncertainty. In order to show our knowledge of the subject at the time of the framing of the treaty the following table has been prepared from all known authorities upon the subject down to the present time.

The last three determinations entered in the table, it must be borne in mind, have been made since the treaty was drawn up.

Date.	Longitude.	Authority.
	° /	
1761	155	Map published by the Imp. Acad. of Sc. of St. Petersburg.
1778	169 52	Cook's Atlas.
1802	168 48	Billings.
1822	168 59	Kotzebue.
1827	168 55	Beechey. Br. Adm. Ch. No. 593.
1828	168 54	Lütke's Atlas.
1849	168 57.5	Tebenkoff's Atlas.*
1852	168 54	Russian Hydr. Ch. No. 1455.
1855	168 48	Rogers. U. S. Hyd. Ch. No. 68.
1874	169 04	Russ. Hyd. Ch. No. —.*
1878	168 58	Onatsevich.
1880	168 58	U. S. C. and G. S.

In the case of the two determinations marked with a * the two Diomedé Islands are so represented on the chart that the boundary line is tangent to each island.

During the past summer an attempt was made by the party on board the U. S. C. and G. S. Schooner Yukon to make a more careful determination of the longitude of this meridian than had been attempted hitherto. For longitude purposes the party had one pocket and six box chronometers. For determining time the sextant was used, recourse being had to equal altitudes whenever possible.

Plover Bay in Eastern Siberia is about 150 miles to the southward and westward from the Diomedé Islands in Behring's Strait. This bay was visited by Prof. Asaph Hall of the U. S. Naval observatory in 1869 for the purpose of observing the total solar eclipse of that year, and, in connection with the eclipse work, Prof. Hall made a careful determination of the longitude of his station. After a careful examination of all the longitude determinations known to exist, and because the facilities for determining the longitude of this place by the Yukon party were not sufficient to improve upon the determination by Prof. Hall, his results have been adopted, and the longitude of the boundary meridian made to depend upon his determination. Before proceeding to give an account of our longitude observations, when near the boundary line, a complete *resumé* of observations for position at Plover Bay, with discussion will be given, this being rendered necessary by the fact that the longitude of the boundary line as well as that of all other points along the Arctic coast and northern part of Behring Sea have been made by us to depend upon Plover Bay.

Previous to 1848 Plover Bay, though an extensive arm of the sea running inland some 20 to 25 miles, appears not to have been known. It is not shown upon any map before 1850. In the period from 1845 to 1848 it seems to have been visited by the whalers. The first information touching it upon which we can lay our hands is the report of Commander Moore to the Admiralty, published in the Nautical Magazine March, 1850. From this it appears that Commander Moore first anchored in Plover Bay, October 17, 1848. Later he moved his vessel, the Plover, farther in, and wintered in the harbor named by him Emma Harbor. He remained in Emma Harbor until June 23, 1849. Concerning the scientific or surveying work accomplished in this period of eight months, he says; "At intervals Mr. Martin, assisted by Mr. Hooper, made a survey

of the place in which I had secured the ship for the winter; which, connected with Mr. Martin's and my own observations on the coast to the westward, will, I hope, give a tolerably correct representation of these shores, and when associated with magnetic observations on every attainable point, will, I trust meet their Lordships' approbation."

The results foreshadowed by this report have not come to light. No map or plan of Emma Harbor, or Plover Bay, has been published by the British Admiralty Office, and no statement or account of the observations at Plover Bay, if any were made. General Sabine in his contributions to Terrestrial Magnetism No. XIII gives some results which he credits to a MS in the Magnetic Office by Commander Moore, but no *magnetic declination* or *intensities* are given; whence we conclude that no observations, or at least no satisfactory observations, therefor, were taken. A few results for *dip* are given. The geographical position of the station where the dip observations were taken is given by General Sabine, and this position, if due to Commander Moore, is the earliest determination on record of a position for Plover Bay. The position given probably refers to some point near the northern shore of Emma Harbor and is

Latitude, 64° 26' N.
Longitude, 173 07 W. Gr.

and the observed dip was 75° 10'. From the best existing chart of Plover Bay that we have, it is found that this station is four minutes north, and nine minutes east of the station occupied by the Coast Survey. Whence we find the Coast Survey Astronomical Station to be, according to Commander Moore, approximately in

Latitude, 64° 22' N.
Longitude, 173 16 W. Gr.

A rough sketch of Plover Bay was made in 1866, by the exploring parties of the Western Union Telegraph Company, and this sketch was published in 1869 by the Coast Survey. The observations were made by Lieut. J. Davison, of the U. S. Revenue Marine Service, and the resulting position is stated to depend upon nine observations referred by a crude triangulation to the mountain Bald Head. The position given by Lieut. Davison for Bald Head is

Latitude, 64° 24' N.
Longitude, 173 15 W. Gr.

From the best chart extant of Plover Bay, which has been referred to above, and which is one published in 1877 by the Russian Hydrographic Office from surveys by Lieut. Onatsevich, we find Bald Head to be one and a half minutes south and one minute east of the Coast Survey Astronomical Station. Hence, according to Lieut. Davison, the Coast Survey Astronomical Station is in

Latitude, $64^{\circ} 25.5' N.$

Longitude, $173^{\circ} 16' W. Gr.$

As the observations were made, *not* on the mountain, but on the vessel at anchor in the harbor, it seems probable that in transferring the position of the vessel to the mountain some mistake occurred, for the resulting latitude is certainly considerably in error.

The next determination of position at Plover Bay was by Prof. Hall, in 1869, during his visit to this place to observe the total solar eclipse of that year. The latitude was determined with a Pistor and Martin's sextant from observations upon August 3, 4, and 5, by Prof. Hall and Mr. J. A. Rogers. The following table gives the results:

Date.	Latitude.				Observer.	No. of Observations.
	$^{\circ}$	$'$	$''$	$'''$		
1869, August 3-----	64	22	22	± 1.3	Rogers-----	15
“ 3-----			22	± 1.9	Rogers-----	14
“ 4-----			33	± 1.9	Hall-----	17
“ 5-----			27	± 1.9	Hall-----	12
“ 5-----			20	± 2.7	Hall-----	12
Mean adopted -----	64	22	25			70

For determining the longitude Prof. Hall had ten chronometers whose corrections to Greenwich time were determined at the Astronomical Station in the Navy Yard on Mare Island, California, before setting out and returning from Plover Bay. The dates of the time determinations at Mare Island, are June 17-20, and September 18-19, 1869, the interval being 102 days. The time was determined with a small portable transit instrument. With these means Prof. Hall obtained the following results for the longitude of his station in Plover Bay, west from the station at Mare Island.

<i>h.</i>	<i>m.</i>	<i>s.</i>
3	24	21.3
		19.1
		21.3
		21.0
		22.7
		22.2
		22.5
		15.9
		23.0
		21.1

These are the results by each chronometer, and when combined by weights indicated by their probable errors, the resulting longitude is

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>s.</i>
3	24	21.1	± 0.36

Since these results were published, the longitude of San Francisco has been determined by telegraph, and the station upon Mare Island occupied by Prof. Hall geodetically connected with this determination. The resulting longitude of the Mare Island station is, according to Assistant Schott of the Coast Survey,

<i>°</i>	<i>'</i>	<i>''</i>	<i>''</i>
122	16	16	± 2.2

or, in time,

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>s.</i>
8	09	05.07	± 0.15

whence we have for the longitude of Prof. Hall's station, at Plover Bay

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>s.</i>
11	33	26.2	± 0.4

For Prof. Hall's station, therefore, we adopt

Latitude,	64°	22'	25''	N.
Longitude,	173	21	33	$\pm 6''$ W. Gr.

Before leaving Washington we were furnished by Prof. Hall with a memorandum, describing his station from which it appears that no permanent station mark could be left by him, the character of the soil and natives preventing this. We were, therefore, unable to locate the exact spot, but had no difficulty in finding the general locality, and fixing upon a place that must have been within a few metres

of Prof. Hall's station. Here we erected a pile of boulders as a beacon, and by means of the telemeter staff, and a small triangulation connected with our azimuth line, we found this beacon to bear N. $1^{\circ} 42' 26''$ E. from our astronomical station, and 462.9 metres distant, or in round numbers 460 metres N. $1^{\circ} 42'$ E. of ours; in arc this is $1''$ E. and $15''$ N. of ours. Applying these reductions to the position already adopted, we have as the position of our station, according to Prof. Hall

Latitude, $64^{\circ} 22' 10''$ N.
Longitude, $173^{\circ} 21' 32 \pm 6''$ W. Gr.

In 1876 the bay was visited by Lieut. M. L. Onatsevich, of the Russian Navy in the "*Vsadnik*," and a rough survey made of the bay with a somewhat detailed survey of the anchorages. At the same time astronomical and magnetic observations were made.

In 1877, the Russian Hydrographic Office published several charts embodying the results of Onatsevich's observations, and among them, a chart of Port Providence, or "Plover Bay," as it is usually called by the whalers. On this chart it is stated that the astronomical station of Lieut. Onatsevich is, according to his observations in

Latitude, $64^{\circ} 21' 37''$ N.
Longitude, $173^{\circ} 18' 30''$ W. Gr.

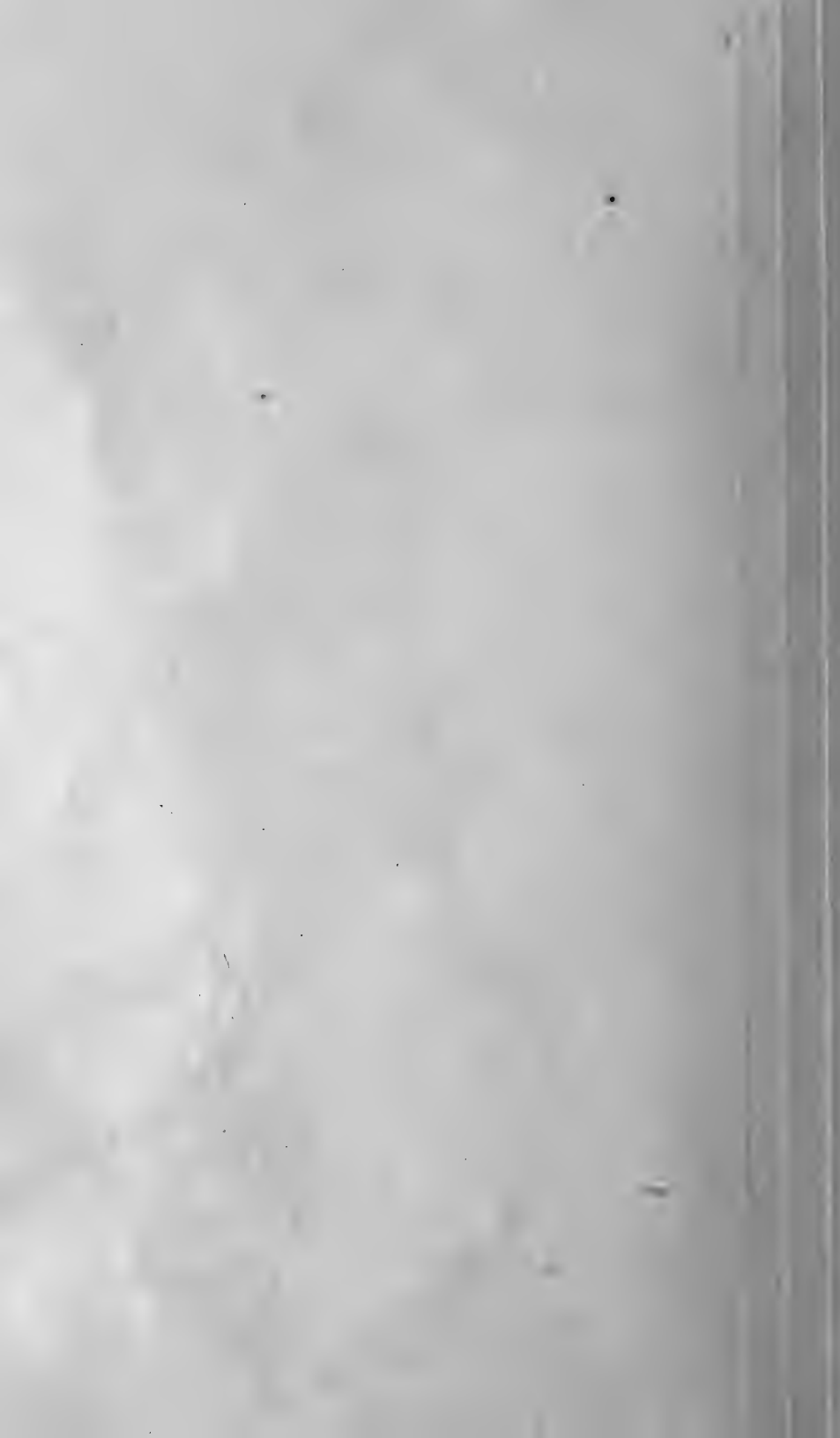
In the following year, however, 1878, Lieut. Onatsevich's report was published, and in this report the position of the astronomical station is stated to be

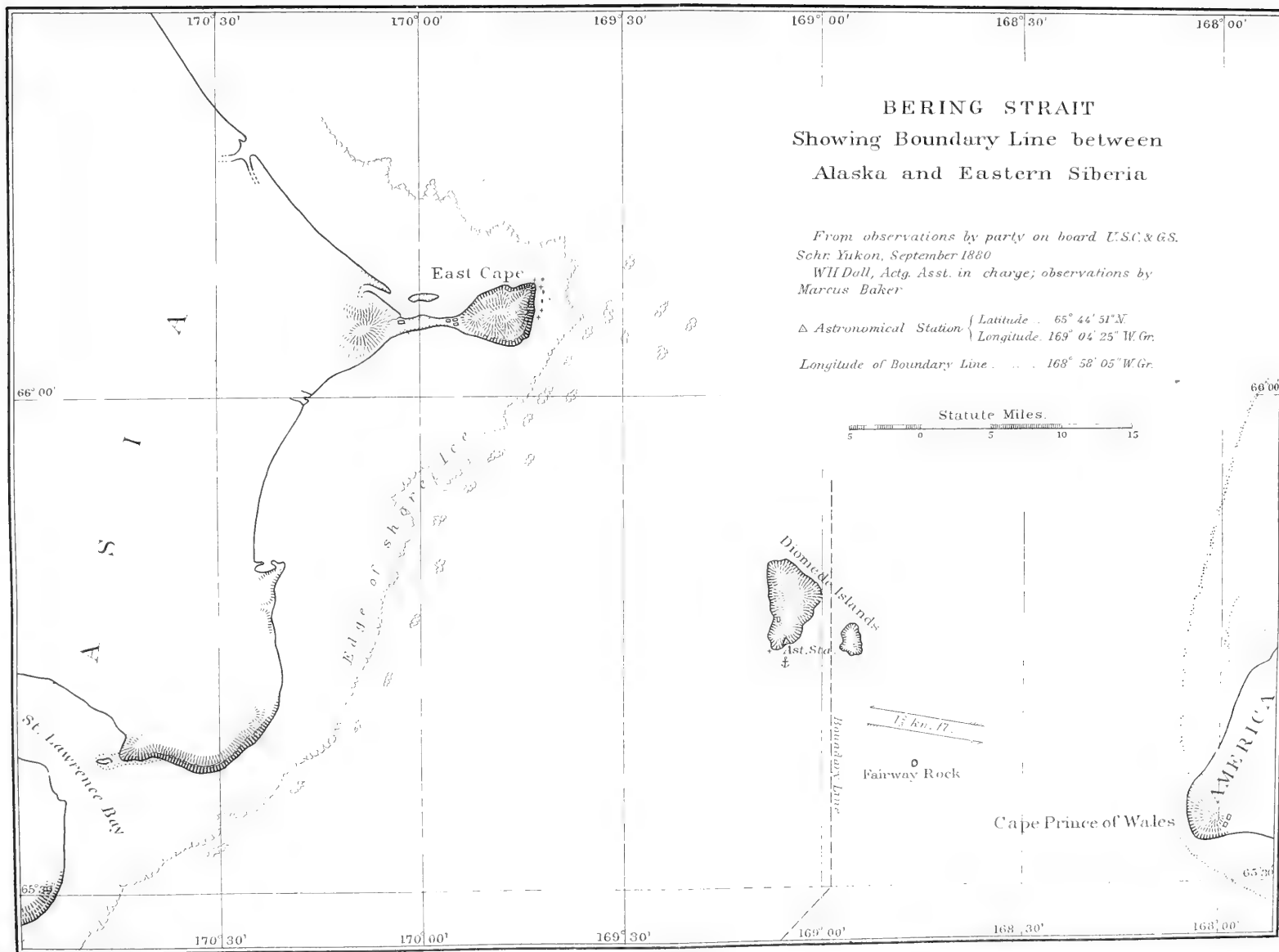
Latitude, $64^{\circ} 21' 55''$ N.
Longitude, $173^{\circ} 23' 54''$ W. Gr.

the longitude depending upon that of Petropavlovsk, which latter is taken as 10h. 34m. 37s. or $158^{\circ} 39' 15''$ E. from Greenwich. This last result appears to be the finally corrected one, and is adopted as Onatsevich's determination.

The station occupied by Lieut. Onatsevich is clearly marked upon his chart, and as we had this chart with us the place was quite closely identified, probably within a few feet. The attempt was made to have our station identical with his, and consequently no reduction is necessary.









Recapitulating, therefore, we have the following results for the position of the Coast Survey Astronomical Station at Plover Bay :

Date.	Latitude.	Longitude.	Authority.
	° ' "	° ' "	
1848-9 -----	64 22	173 16	Com'r T. E. L. Moore. (?)
1866 -----	25.5	16	Lieut. J. Davison.
Aug., 1869 -----	22 10	21 32	Prof. A. Hall.
July, 1876 -----	21 55	23 54	Lieut. M. L. Onatsevich.
Sept., 1880 -----	21 54	-----	U. S. C. and G. S., by M. Baker.

Discussion of foregoing Table.

It is very doubtful whether the results credited to Commodore Moore were really obtained by him, or whether General Sabine took these values from other sources; while the results by Lieut. Davison are known to have been of only a very approximate character. The three remaining results for latitude, when we consider that they were made at different times, by different observers, at different stations, and with different instruments and the instruments of a secondary character, show a satisfactory agreement, and we adopt the simple mean for the latitude determination, which is $64^{\circ} 22' 00''$ and would assign an arbitrary probable error of $6''$.

Neglecting the longitude results by Moore and Davison as being of an inferior character, we have the two remaining by Hall and Onatsevich. The determination by Onatsevich is a chronometric one from Petropavlovsk. How the longitude of Petropavlovsk was obtained we are not informed, but we know it was not determined by telegraph. Moreover the longitude adopted by Onatsevich for Petropavlovsk differs by as much as four miles, ($4' 11.7'' = 16.8s$) from that adopted by the Russian Hydrographic Office, in 1850, as the basis for their charts of this region, and which determination was the mean of nine different determinations extending from 1779 to 1827. The longitude of Plover Bay based upon Onatsevich's observations and that longitude of Petropavlovsk is $173^{\circ} 19' 22''$ W. Gr.

It has, therefore seemed best to adopt without change the result of Prof. Hall's observations, not combining it with anything else, viz: $173^{\circ} 21' 32'' \pm 6''$ W. Gr.

Our adopted value, therefore, of the geographical position of the Astronomical Station of the U. S. Coast and Geodetic Survey at Plover Bay, Eastern Siberia, is

$$\begin{array}{lcl} \text{Latitude,} & 64^{\circ} & 22' \quad 00'' \pm 6'' \quad \text{N.} \\ \text{Longitude,} & \left\{ \begin{array}{lll} 173 & 21 & 32 \pm 6 \\ \text{h.} & \text{m.} & \text{s.} \end{array} \right. & \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{W. Gr.} \\ & \left\{ \begin{array}{lll} 11 & 33 & 26.1 \pm 0.4 \end{array} \right. & \end{array}$$

One station was marked by driving a piece of whale's rib into the ground and piling rocks around it. Being identical with the station of Lieut. Onatsevich, any one visiting the place will by the aid of that chart readily identify it.

Having completed our investigation of the geographical position of Plover Bay, we proceed to detail our observations for the longitude of the boundary.

The Yukon arrived at Plover Bay at ten in the evening of August 11, 1880. The following day was cloudy in the morning, afterward rained, and later partially cleared up so that we obtained two pairs of equal altitudes of the sun for time, the interval being about three hours. During the afternoon we succeeded in getting four sets of six each of double altitudes of the sun for time. From the equal altitudes the time of local mean noon by the chronometer, was 11h. 18m. 13.9s, and from the double altitude it was 11h. 18m. 14.2s., a very satisfactory agreement. By means of the intervals the probable errors of each of these determinations have been made out. For the equal altitudes it is ± 1.7 s, and for the double altitudes it is ± 0.30 s, values which may be taken as fairly representative of the different conditions under which the observations were made. From these observations the corrections of our chronometers to Greenwich mean time on August 12 were determined.

On August 14, we sailed from Plover Bay to the eastward and northward, cruising along the Arctic coast as far as Point Belcher, and returning thence passed through Behring Strait to Port Clarence, and afterwards returning to Behring Strait made a landing on the southeastern shore of Ratmanoff, or the Big Diomedé Island, on September 10. We came to anchor at seven in the morning, about a mile off shore, and sailed away about three in the afternoon. During our stay observations were made for latitude and time, and all the magnetic elements, declination, dip and intensity. Of time observations three sets of six each of double altitudes of

the sun were obtained with sextant and artificial horizon. These three sets give as the correction of our "hack," or observing chronometer, to local mean time

$$\begin{array}{rcccl} h. & m. & s. & s. & \\ + 1 & 03 & 26.9 & \pm 0.35, & \end{array}$$

this probable error resulting from computing the eighteen observations singly and treating in the usual way. The sky was nearly covered with cumulus clouds, the wind fresh, raw and chilly, and thermometer 39° F. Near noon the sun appeared again for a short time, and nine pointings were obtained for latitude, giving the following results, each depending upon a single observation.

65°	44'	54''
		50
		38
		54
		44
		52
		53
		60
		65

Mean latitude, $65^{\circ} \quad 44' \quad 51 \pm 1.''5$ N.

Leaving the Diomedes on the afternoon of September 10, we sailed directly for Plover Bay. That night we were stopped by ice, the next day delayed by calms, but on the following day, September 12, we reached our anchorage in Plover Bay a little before noon, just in time to get a good series—39 observations of circummeridian altitudes of the sun for latitude. In the afternoon we obtained a good series of time observations, but the following morning was cloudy. We succeeded, however, in getting four altitudes corresponding to those of the preceding day, thus enabling our time determination to hang upon four pairs of equal altitudes, the epoch being local mean midnight September 12 and 13. The times of local apparent midnight from these four pairs by our "hack" were

<i>h.</i>	<i>m.</i>	<i>s.</i>
11	09	0.2
		1.2
		0.3
		0.7

from which the probable error is found to be $\pm 0.15s$.

For the longitude of our station upon the Big Diomed Island we have, therefore, as follows:

Plover Bay-----	1880, Aug. 12, noon	Chron'r corr'n determined, ± 1.7 s.
Big Diomed Id., "	Sept. 10, 8.9 h. a. m.,	" " ± 0.35
Plover Bay-----	" " 12, midnight---	" " ± 0.15

By means of the time determinations of August 12 and September 12, the rates of the chronometers are determined and then the Greenwich time determination at Big Diomed Island, September 10, is made to depend upon the determination at Plover Bay, September 12, and the rates of all the chronometers carried back to September 10, a period of 2.64 days.

The resulting longitude by each chronometer is shown in the following table:

Chron'r.	<i>h.</i>	<i>m.</i>	<i>s.</i>
214 --	11	16	18.3
866 --			17.9
1131 --			18.0
1713 --			19.0
2535 --			14.7
311 --			16.6

Chronometer No. 2535 was our "hack," and 311 a sidereal chronometer used in making comparisons. Each had rather large rates, that of 2535 exceeding *nine* seconds, and that of 311 *five* seconds per day. The indiscriminate mean of all is 11*h.* 16*m.* 17.4*s.* Assigning only half weight to chronometer 2535, the longitude resulting is

<i>h.</i>	<i>m.</i>	<i>s.</i>
11	16	17.7

The probable error of the Greenwich time at the Diomedes, based upon the agreement of the chronometer is ± 0.36 s.

For the probable error of the longitude, therefore, we have

Probable error of longitude of Plover Bay-----	± 0.39 s.
Probable error local time determination, Plover Bay, Sept. 12-----	± 0.15
Probable error local time determination, Diomedes, Sept. 10-----	± 0.35
Probable error Greenwich time determination, Diomedes, Sept. 10.==	± 0.36

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>s.</i>
Resulting longitude adopted,	11	16	17.7 ± 0.65 .

The astronomical station of the United States Coast and Geodetic

Survey at the mouth of the ravine, on the southeastern shore of the Big Diomedé Island, in Behring Strait, is, therefore, in

Latitude, $65^{\circ} 44' 51''$ N.
 Longitude, $169^{\circ} 04' 25 \pm 10'$ W. Gr.

From bearings and angles taken from the astronomical station and from the schooner at anchor, using the distance of the schooner from the station as a base line, together with other bearings taken while in the vicinity of the islands, a sketch of the two islands has been prepared from which it appears that the meridian tangent to the extreme eastern edge of the larger island is 2.1 nautical miles, and the meridian tangent to the extreme western edge of the smaller island is 3.1 nautical miles, east of the astronomical station. The boundary line is to pass midway between these meridians, *i. e.* the meridian which forms the boundary is 2.6 nautical miles east of the astronomical station.

In latitude $65^{\circ} 45'$, the latitude of the astronomical station, 2.6 nautical miles is equal to $6' 20''$ of longitude, and, deducting this from the longitude of the astronomical station, the longitude of the boundary line is found to be

$168^{\circ} 58' 05''$ W. Gr.

If we assume an uncertainty of one quarter of a nautical mile, equal in this latitude to $37''$ of longitude, in thus transferring the position of the station to the boundary line, and this seems to be quite large enough, we have finally as the longitude of the boundary line between Alaska and Eastern Siberia

$168^{\circ} 58' 05 \pm 38''$

or, in time,

$11^h 15^m 52.3 \pm 2.5$ W. Gr.

ERRATA.

Page 126, line 6 from bottom, *for* "and returning" *read* "and after returning."

For "Behring," *read* "Bering," throughout this article.

196TH MEETING.

MARCH 19, 1881.

Vice-President TAYLOR in the Chair.

Thirty members and visitors present.

The minutes of the last meeting were read and adopted.

The communication for the evening was by Mr. J. W. POWELL, on

LIMITATIONS TO THE USE OF SOME ANTHROPOLOGIC DATA.

This paper is published in full in the "Abstract of Transactions of the Anthropological Society of Washington, D. C., for the first year ending January 20, 1880, and the second year ending January 18, 1881."

Remarks upon this communication were made by Messrs. GILL, HARKNESS, WARD, NEWCOMB, and ALVORD.

At the conclusion of the discussion the Society adjourned.

197TH MEETING.

APRIL 2D, 1881.

Vice-President TAYLOR in the Chair.

Thirty-nine members and visitors present.

The consideration of the minutes of the last meeting was postponed, the recorder being absent.

Dr. ANTISELL, on behalf of the committee appointed at the last meeting of the Society, reported the following resolution in commemoration of the late Dr. GEORGE A. OTIS:

Resolved, That this Society has heard with profound regret of the untimely death, on the 23d of February last, of Dr. GEORGE A. OTIS, U. S. Army, one of its original founders.

Resolved, That while we deplore the loss of so highly valued an associate and friend, there is some compensation to be found in the reflection that his long and incessant suffering has at last terminated, and that it is gratifying to remember that he was not cut off before his services to science, in his chosen field, had received, as well in Europe as in America, the high appreciation which they so richly merited.

Resolved, That the medical literature, not only of this country but of the world, has sustained by this calamity a loss which can with difficulty be replaced.

A communication was then read by Mr. A. B. JOHNSON on
THE HISTORY OF THE LIGHT HOUSE ESTABLISHMENT OF THE
UNITED STATES.

Mr. JOHNSON read from a paper he had prepared for publication elsewhere, on the History of the Light-house Establishment of the United States, tracing its rise and progress from the first beacon which was erected on Point Allerton, entrance to Boston Harbor, in 1673, to the present time. He gave some account of the eight light-houses built by the Colonies; then of twelve built by the General Government prior to 1812, then of the progress of the establishment, under the charge of Mr. Pleasanton, an Auditor of the U. S. Treasury and the Acting Superintendent of the Lights, when the number increased to some three hundred and twenty-five; then of the causes which led to the creation of the provisional Light-House Board, and then of the erection of the permanent Light-House Board, and of the improvements the Board had since made, in all the arts and sciences connected with the erection of the light-houses and the establishment of cognate aids to navigation. Mr. JOHNSON then gave some account of light-house construction and of the different kinds of light-towers, material and style of the structures used, and of the problems solved in deciding on the various subaqueous foundations required. He illustrated his subject by the exhibition of large photographs of such stone light-houses as that on Spectacle Reef, Michigan, of such harbor lights as that on Thimble Shoal, entrance to Hampton Roads, Virginia, such skeleton iron houses on driven piles as that on Fowey Rocks, Florida Reef, and the tripod erected on Paris Island, Port Royal Sound, S. C., and of the remarkable stone light-house recently built on the summit of Tillamook Rock off the coast of Oregon.

Some account was given of the fog-signals used in this country, and a large crayon of the syren, the most powerful fog signal known, was shown.

Mr. JOHNSON spoke of the fact thus noted by Professor Henry: "It frequently happens on a vessel leaving a station that the sound is suddenly lost at a point in its course, and after remaining inaudible some time, is heard again at a greater distance, and is then gradually lost as the distance is further increased." In connection with this he exhibited a chart showing the site of Beaver Tail Light-House on the south point of Conanicut Island, between the two

entrances to Narragansett Bay, with Bonnet Point, on which the steamer Rhode Island was wrecked in the fall of 1880, one and one-half miles to the northwest, with Fort Adams three and one-quarter miles to the northeast, and distant one and one-half miles to the southeast. On this chart was indicated the route of a sail boat which had been run to Bonnet Point, thence southerly to near Whale Rock; thence easterly close to Beaver Tail; thence northeasterly to Fort Adams, and thence southeasterly to Newport. On the route followed by the boat, he had indicated by half inch circles, the audibility of the fog-signal in full blast at Beaver Tail, as heard in the boat; the degrees being shown by the various shades; full audibility being indicated by darkening the whole surface of the circle, and complete inaudibility being shown by lack of shading in the circle. In this way it was shown that the observer, an officer of the Navy, found the sound of the fog-signal faint at half a mile from the signal, fainter at three-fourths of a mile off, much louder at a mile, less loud at one and one-eighth miles; he lost the sound entirely at one and one-fourth miles; at one and three-sixteenths miles he heard it faintly, and right under Bonnet Point, one and one-half miles distant, he heard it stronger than he did at one-half mile from the signal. In the run of about one mile from Bonnet Point toward Whale Rock he did not hear the fog-signal at all, and then he heard it faintly, and as he then ran almost toward the signal he lost its sound entirely; when about a half a mile west of the signal he heard its sound quite faintly, and then lost it, not hearing it again till within one-fourth of a mile when he suddenly heard it at its full power and continued to do so on his run to Newport until three-fourths of a mile away, when the sound diminished one-half, and continued so at one mile off and one and one-fourth miles off. At one and one-half miles distance the sound had diminished to about one-fourth of its power; at two miles off he lost it; he did not hear a trace of it at two and one-fourth, two and a half, or two and three-fourths miles distances; but he caught it faintly as he rounded Fort Adams at three miles away, and when he had run another one-fourth of a mile into Newport Harbor he heard it at almost its full power and continued to do so for another quarter of a mile, when he lost it all together.

Mr. JOHNSON called attention to the fact that in the run of this boat, the sound of the fog-signal had ranged from audibility to to inaudibility, and back again, several times; and that while it

was lost at a distance of about a mile, it was distinctly, though faintly heard at Bonnet Point, distant one and one-half miles, and that while it was lost completely at two miles off, on the run to Newport, it was picked up at Fort Adams, three miles off, and heard almost at its full power at three and one-fourth and three and one-half miles away. These records were made by Lieut. Com. F. E. Chadwick, U. S. N., Assistant Light-House Inspector, to ascertain the facts, bearing on the statement that the fog-signal stopped from time to time, made by those who had noticed these intermissions of audibility; and the fact that the fog-signal was in continuous full blast, was noted by his assistant, who remained at Beaver Tail for the purpose.

Mr. JOHNSON stated that this ricocheting of sound, these intervals of audibility, ought to be recognized by the mariner, who should now understand that in sailing toward or from a fog-signal in full blast, he might lose and pick up its sound several times though no apparent object might intervene. And the mariner now needed that science should deduce the law of this variation in audibility and bring out some instrument which should be to the ears what the mariner's compass is now to the eyes, and also that variations of this instrument yet to be invented, be provided for and corrected as now are the variations of the mariner's compass. The speaker referred to the benefit the mariner had derived from the promulgation of Professor Henry's theory of the tilting of the sound wave up or down by adverse or favorable winds, and said that by this the sailor had been led to go aloft in the one case and to get as near as possible to the surface of the water in the other, when trying to pick up the sound of a fog-signal.

In this connection Mr. JOHNSON read the following extract from an article entitled *Signaling by Means of Sound*, by E. Price-Edwards, from the [*English*] *Journal of the Society of Arts*:

"In one respect, however, the late Professor Henry, who was at the time chairman of the United States Light-House Board, differed from Dr. Tyndall, viz: in regard to the theory of acoustic clouds, and their resultant aerial echoes. Professor Henry's explanation of the obstruction of sound in clear weather, and the echoes, is founded upon the asserted existence of upper and lower currents of air, the tilting up of the sound wave, and the reflection of the sounds from the surface of the sea, or the crests of the

wave. From this last explanation, Professor Henry seems to have receded before his death."

Mr. JOHNSON said that he called attention to this statement, as he was satisfied that Mr. Price-Edwards had permitted himself to fall into some inaccuracy as to Prof. Henry's action in this matter. It was within Mr. Johnson's personal knowledge that Prof. Henry, up to the last, had considered the theory of the tilting of the sound wave, under certain conditions, as a good working hypothesis. The Professor had it in contemplation when he was called from his labors to attempt the solution of certain of the questions connected with this subject by stationing observers in steamers, around a vessel anchored far enough from shore to be out of reach of land echoes, on which a powerful fog-signal should be in operation, and these observers should be aided by others in captive balloons, who should note simultaneously with them, upon charts and tables previously prepared, not only the audibility of the signal, but all the other data which could be obtained from the action of the thermometer, the hygrometer, and the anemometer, as to the then condition of the atmosphere. When all this information should be tabulated, Professor Henry hoped to deduce something more of the law of the movement of the sound wave under given conditions, and to formulate it for the benefit of the mariner. This was a work which Professor Henry had left to his successors and which the speaker believed they would not neglect.

Mr. JOHNSON then took up an article in the *Annales des Ponts et Chaussées* for October, 1880, by M. Emile Allard, *Inspecteur General des Ponts et Chaussées*, entitled *Comparison de Quelques Depenses Relative au Service des Phares en France, aux Etats-Unis et en Angleterre*, and called attention to that portion of it in which it was stated in effect, that the lighted coast of the United States measured about 7,500 nautical miles, and that the estimate of the Light-House Board of the expense of maintaining the Light-House Service for the year ending June 30, 1880, was \$2,046,500, and that hence the cost to the United States for lighting each nautical mile of its coast was 1,293 francs, while that of France which had twenty-five lights to the one hundred nautical miles [the United States having but about nine lights to that distance] was but 1,155 francs.

Mr. JOHNSON then showed that the length of the lighted coasts of the United States, except those of the Mississippi, Missouri, and Ohio rivers, measured on a ten-mile chord, was 9,959 miles, giving, as his authority, recent statements made on this point by the United States Coast and Geodetic Survey and of the office of the Chief of Engineers of the United States Army; the one as to the length of the ocean, gulf, sound, and bay coast, and of the lighted rivers beside those above named; and the other as to the length of the lighted lake coasts. He then pointed out the natural mistake of M. Allard, in supposing that the amount of the Board's estimates (*Le Budget Annuel du Bureau des Phares*) had been appropriated by Congress for its support; and he showed instead that the appropriations were much less than the estimates, and that, owing to various causes, the appropriations even had not all been expended, so that the actual expenses of maintaining the United States Light-House Establishment for the year ending June 30, 1880, were but \$1,943,600 instead of \$2,046,500, as M. Allard had inferred. Hence, it followed that, while it costs France 1,155 francs to light each nautical mile of her coast, it costs but 922.7 francs to light each nautical mile of United States coast, instead of 1,293 francs as has been erroneously inferred by M. Allard.

Mr. JOHNSON closed by stating that the Light-House Establishment of the United States had been largely modeled on that of France; that the Light-House Board, while it still hoped to reach the French standard in many things, hardly expected to attain to certain of its economies; that he should not have thought of comparing the cost of the maintenance of the two establishments, but as this comparison had been made in the official French journal, he had thought it well, and due to the science of pharology, to correct the errors which had crept into the calculations of this high officer in the French Light-House Service.

The paper from which Mr. JOHNSON read, and on which he based his remarks, may be found in full in the Annual Appendix for 1880, to be published by the Appletons as Volume XX of the New American Cyclopedia.

Remarks on this paper were made by Messrs. HILGARD and THORNTON A. JENKINS. The latter gave some interesting reminiscences of his early connection with the light-house service.

Mr. TAYLOR said that he wished to emphasize a single point in Mr. Johnson's communication, namely, that referring to Mr. Price-Edwards' statement in regard to the supposed change of view by Prof. Henry as to the explanation of acoustic disturbances, or, at least, as to the source of the ocean echo. The only thing which could give the slightest color to such a supposition was a purely incidental and wholly unimportant suggestion thrown out by Prof. Henry on this subject. Discarding the proposed explanation of the echo by the presence of a hygroscopic flocculence, or invisible acoustic clouds in the air, as quite insufficient in character, as too indefinite in limits, and as too mutable and evanescent in duration, in a mobile atmosphere, to account for so pronounced, distinct, and uniform a phenomenon, Prof. Henry thought, in the absence of any other sufficient surface, that, in view of the large amount of curvature in ordinary sound beams, acoustic waves might be reflected back to the ear from the ocean itself,—probably from the sloping sides of the waves. On having his attention drawn by Prof. Tyndall to the circumstance that the echoes were frequently distinct over a perfectly smooth sea, he admitted that this would invalidate the suggestion of wave crests being concerned in the effect; but he still believed that, with sounds sufficiently powerful to reach considerable distances, it was quite possible for some of the upper sound-beams to be so curved as to be reflected upward from a perfectly level floor, and still to reach an observer's ear placed near the origin of sound. He had also shown that *visible* clouds were quite incompetent to return any sensible echo to the loudest sounds.

So far from receding from his views in regard to the occasions of irregularity in the audibility of sound, in his last Report of the Light-House Board—that for 1877, published but a short time before his death—he announced his previous conclusions as only more confirmed by his later observations; and a summary of these conclusions was also published in the Smithsonian Report for 1877.

The ideas of sound transmission promulgated in popular books and lectures, as derived from class-room experiments, are very inaccurate and misleading when applied to any considerable range of sound travel. Were the medium of sound propagation—the atmosphere—perfectly homogeneous in density, in temperature, and in movement, the beams would indeed travel in sensibly straight lines, but still with a large amount of lateral diffusion bearing no analogy to the diffraction of light. But in distances of several miles—

say from one to ten, as involved in fog-signaling,—it may be said that such conditions of aerial uniformity are *never* present; or in other words that sound beams are never transmitted for any great distance in sensibly straight lines. And hence it is, that after every allowance for lateral deflection, there frequently remain under peculiar circumstances, intermediate points of acoustic darkness, or belts and regions of insulated silence.

The next communication was by Mr. E. B. ELLIOTT, who read from a cablegram from Berlin relative to the Monetary Conference about to meet at Paris, that a fixed legal ratio of value of gold to silver of $15\frac{1}{2}$ to 1, and the unrestricted coinage of both metals at this fixed ratio of value, were to be presented to the Convention as the leading subjects for discussion, and prospective adoption.

The present market ratio is about 18 to 1, the proposed ratio $15\frac{1}{2}$ to 1. Now one ounce of gold and eighteen ounces of silver are equivalents for debt-contracting and debt-paying purposes, but the proposition is that the nations enact that one ounce of gold and $15\frac{1}{2}$ ounces of silver shall be legal equivalents for debt-paying purposes, the option of deciding in which of the two metals the payment shall be reckoned and paid, to be with the person making the payment, or debtor. It is a proposition then to allow the debtor to scale down his debt from 18 to $15\frac{1}{2}$, to scale down his payments 14 per cent. from the existing standard;—a proposition that the nations in the payment of their public debts may diminish their payments 14 per cent. and also, that the people in their several countries may liquidate their debts, public and private at the same reduced rate, 14 per cent.

The adoption of this scheme of partial repudiation by our own or any other nation would of necessity prove disastrous to its credit.

The ability of our own country to pay its indebtedness is believed to be unsurpassed by any on the face of the globe, but its willingness is questioned, and the sending of a Commission to Europe, and inviting a conference of nations to favorably consider the subject of scaling down the value of the monetary unit of account, must tend to the depression of that credit.

If, with that doubt impending as to our *willingness* to make full payment of our indebtedness, our nation can borrow at the low rate of $3\frac{1}{2}$ or $3\frac{1}{4}$ per cent. per annum, there is reason to believe that,

with that doubt dispelled, our bonds can readily be placed on the world's market at the greatly improved rate of 3 per cent. per annum.

To this end it is desirable: (1), that the forced coinage of our legal tender silver dollar (of 412½ grains silver 9-10 fine) be discontinued; (2), that on all future coins and on bullion, be stamped their weight in grammes, and their fineness 9-10; and (3) that an international commission be created whose duty it shall be to periodically (annually or oftener) proclaim, based on the market quotations of the few months immediately preceding the date of the proclamation, the value in gold of an equal weight of silver; and (4) that the metric-stamped coin and bullion at the proclaimed ratio of value, shall each be equally legal tender of payment in unlimited amount, until the issuing of the next periodical proclamation.

This would be true bi-metallism. The adoption of the proposed ratio, 15½, would be silver mono-metallism under the misnomer of bi-metallism.

By the adoption of the true bi-metallic method proposed—*i. e.*, frequent periodical publication of the true market ratio, instead of a single arbitrary proclamation to last for all time—we should stand before the world with our willingness to pay undoubted, and our ability to pay unsurpassed and paramount among the nations, and our national debt could be placed on the market on more favorable terms than that of any other commercial country.

At the conclusion of Mr. Elliott's remarks, the Society adjourned.

198TH MEETING.

APRIL 16, 1881.

The President in the Chair.

Fifty-four members and visitors present.

The minutes of the 196th and 197th meetings were read and adopted.

The Chair announced to the Society the election to membership of Mr. WILLIAM A. DECAINDRY.

The first communication of the evening was by Mr. ALEXANDER GRAHAM BELL, announcing to the Society, the discovery of

THE SPECTROPHONE.

In a paper read before the American Association for the Advancement of science, last August, I described certain experiments made by Mr. Sumner Tainter and myself, which had resulted in the construction of a "*Photophone*," or apparatus for the production of sound by light;* and it will be my object to-day to describe the progress we have made in the investigation of photophonic phenomena since the date of this communication.

In my Boston paper the discovery was announced, that thin disks of very many different substances *emitted sounds* when exposed to the action of a rapidly-interrupted beam of sunlight. The great variety of material used in these experiments led me to believe that sonorousness under such circumstances would be found to be a general property of all matter.

At that time we had failed to obtain audible effects from masses of the various substances which became sonorous in the condition of thin diaphragms, but this failure was explained upon the supposition that the molecular disturbance produced by the light was chiefly a surface action, and that under the circumstances of the experiments, the vibration had to be transmitted through the mass of the substance in order to affect the ear. It was therefore supposed that, if we could lead to the ear, air that was directly in contact with the illuminated surface, louder sounds might be obtained, and solid masses be found to be as sonorous as thin diaphragms. First experiments made to verify this hypothesis pointed towards success. A beam of sunlight was focussed into one end of an open tube, the ear being placed at the other end. Upon interrupting the beam, a clear, musical tone was heard, the pitch depending upon the frequency of the interruption of the light, and the loudness upon the material composing the tube.

At this stage our experiments were interrupted, as circumstances called me to Europe.

While in Paris a new form of the experiment occurred to my mind, which would not only enable us to investigate the sounds

* Proceedings of American Association for the Advancement of Science, Aug. 27th, 1880; see, also, American Journal of Science, vol. xx, p. 305; Journal of the American Electrical Society, vol. iii, p. 3; Journal of the Society of Telegraph Engineers and Electricians, vol. ix, p. 404; Annales de Chimie et de Physique, vol. xxi.

produced by masses, but would also permit us to test the more general proposition that *sonorosity, under the influence of intermittent light, is a property common to all matter.*

The substance to be tested was to be placed in the interior of a transparent vessel made of some material, which (like glass) is transparent to light, but practically opaque to sound.

Under such circumstances the light could get in, but the sound produced by the vibration of the substance could not get out. The audible effects could be studied by placing the ear in communication with the interior of the vessel by means of a hearing tube.

Some preliminary experiments were made in Paris to test this idea, and the results were so promising that they were communicated to the French Academy on the 11th of October, 1880, in a note read for me by Mr. Antoine Breguet.* Shortly afterwards I wrote to Mr. Tainter, suggesting that he should carry on the investigation in America, as circumstances prevented me from doing so myself in Europe. As these experiments seemed to have formed the common starting point for a series of independent researches of the most important character carried on simultaneously in America by Mr. Tainter, and in Europe by M. Mercadier,† Prof. Tyndall,‡ W. E. Röntgen,§ and W. H. Preece,|| I may be permitted to quote from my letter to Mr. Tainter the passage describing the experiments referred to:

“METROPOLITAN HOTEL, RUE CAMBON, PARIS,

“Nov. 2, 1880:

“DEAR MR. TAINTER: * * * I have devised a method of producing sounds by the action of an intermittent beam of light from substances that cannot be obtained in the shape of thin diaphragms or in the tubular form; indeed, the method is specially adapted to testing the generality of the phenomenon we have discovered, as it can be adapted to solids, liquids, and gases.

“Place the substance to be experimented with in a glass test-tube,

* *Comptes Rendus*, vol. xcl, p. 595.

† “Notes on Radiophony,” *Comptes Rendus*, Dec. 6 and 13, 1880; Feb. 21 and 28, 1881. See, also, *Journal de Physique*, vol. x, p. 53.

‡ “Action of an Intermittent Beam of Radiant Heat upon Gaseous Matter.” *Proc. Royal Society*, Jan. 13, 1881, vol. xxxi, p. 307.

§ “On the tones which arise from the intermittent illumination of a gas.” See *Annalen der Phys. und Chemie*, Jan., 1881, No. 1, p. 155.

|| “On the conversion of Radiant Energy into Sonorous Vibration.” *Proc. Royal Society*, March 10, 1881, vol. xxxi, p. 506.

connect a rubber tube with the mouth of the test-tube, placing the other end of the pipe to the ear. Then focus the intermittent beam upon the substance in the tube. I have tried a large number of substances in this way with great success, although it is extremely difficult to get a glimpse of the sun here, and when it does shine the intensity of the light is not to be compared with that to be obtained in Washington. I got splendid effects from crystals of bichromate of potash, crystals of sulphate of copper, and from tobacco smoke. A whole cigar placed in the test-tube produced a very loud sound. I could not hear anything from plain water, but when the water was discolored with ink a feeble sound was heard. I would suggest that you might repeat these experiments and extend the results," &c., &c.

Upon my return to Washington in the early part of January.* Mr. Tainter communicated to me the results of the experiments he had made in my laboratory during my absence in Europe.

He had commenced by examining the sonorous properties of a vast number of substances enclosed in test-tubes in a simple empirical search for loud effects. He was thus led gradually to the discovery that cotton-wool, worsted, silk, and fibrous materials generally, produced much louder sounds than hard rigid bodies like crystals, or diaphragms such as we had hitherto used.

In order to study the effects under better circumstances he enclosed his materials in a conical cavity in a piece of brass, closed by a flat plate of glass. A brass tube leading into the cavity served for connection with the hearing-tube. When this conical cavity was stuffed with worsted or other fibrous materials the sounds produced were much louder than when a test-tube was employed. This form of receiver is shown in Figure I.

Mr. Tainter next collected silks and worsteds of different colors, and speedily found that the darkest shades produced the best effects. Black worsted especially gave an extremely loud sound.

As white cotton wool had proved itself equal, if not superior, to any other white fibrous material before tried, he was anxious to obtain colored specimens for comparison. Not having any at hand, however, he tried the effect of darkening some cotton-wool with lamp-black. Such a marked reinforcement of the sound resulted that he was induced to try lamp-black alone.

About a teaspoonful of lamp-black was placed in a test-tube and

* On the 7th of January.

exposed to an intermittent beam of sunlight. The sound produced was much louder than any heard before.

Upon smoking a piece of plate-glass, and holding it in the intermittent beam with the lamp-black surface towards the sun, the sound produced was loud enough to be heard, with attention, in any part of the room. With the lamp-black surface turned from the sun the sound was much feebler.

Mr. Tainter repeated these experiments for me immediately upon my return to Washington, so that I might verify his results.

Upon smoking the interior of the conical cavity shown in Figure I, and then exposing it to the intermittent beam, with the glass lid in position as shown, the effect was perfectly startling. The sound was so loud as to be actually painful to an ear placed closely against the end of the hearing-tube.

The sounds, however, were sensibly louder when we placed some smoked wire gauze in the receiver, as illustrated in the drawing, Figure I.

When the beam was thrown into a resonator, the interior of which had been smoked over a lamp, most curious alternations of sound and silence were observed. The interrupting disk was set rotating at a high rate of speed, and was then allowed to come gradually to rest. An extremely feeble musical tone was at first heard, which gradually fell in pitch as the rate of interruption grew less. The loudness of the sound produced varied in the most interesting manner. Minor reinforcements were constantly occurring, which became more and more marked as the true pitch of the resonator was neared. When at last the frequency of interruption corresponded to the frequency of the fundamental of the resonator, the sound produced was so loud that it might have been heard by an audience of hundreds of people.

The effects produced by lamp-black seemed to me to be very extraordinary, especially as I had a distinct recollection of experiments made in the summer of 1880 with smoked diaphragms, in which no such reinforcement was noticed.

Upon examining the records of our past photophonic experiments we found in vol. vii, p. 57, the following note:

“Experiment V.—Mica diaphragm covered with lamp-black on side exposed to light.

“Result: distinct sound about same as without lamp-black.—
A. G. B., July 18th, 1880.”

"Verified the above, but think it somewhat louder than when used without lamp-black."—*S. T.*, *July 18th*, 1880.

Upon repeating this old experiment we arrived at the same result as that noted. Little if any augmentation of sound resulted from smoking the mica. In this experiment the effect was observed by placing the mica diaphragm against the ear, and also by listening through a hearing-tube, one end of which was closed by the diaphragm. The sound was found to be more audible through the free air when the ear was placed as near to the lamp-black surface as it could be brought without shading it.

At the time of my communication to the American Association I had been unable to satisfy myself that the substances which had become sonorous under the direct influence of intermittent sunlight were capable of reproducing sounds of articulate speech under the action of an undulatory beam from our photophonic transmitter. The difficulty in ascertaining this will be understood by considering that the sounds emitted by thin diaphragms and tubes were so feeble that it was impracticable to produce audible effects from substances in these conditions at any considerable distance away from the transmitter; but it was equally impossible to judge of the effects produced by our articulate transmitter at a short distance away, because the speaker's voice was directly audible through the air. The extremely loud sounds produced from lamp-black have enabled us to demonstrate the feasibility of using this substance in an articulating photophone in place of the electrical receiver formerly employed.

The drawing (Fig. 2) illustrates the mode in which the experiment was conducted. The diaphragm of the transmitter (A) was only 5 centimeters in diameter, the diameter of the receiver (B) was also 5 centimeters, and the distance between the two was 40 meters, or 800 times the diameter of the transmitter diaphragm. We were unable to experiment at greater distances without a heliostat on account of the difficulty of keeping the light steadily directed on the receiver. Words and sentences spoken into the transmitter in a low tone of voice were audibly reproduced by the lamp-black receiver.

In Fig. 3 is shown a mode of interrupting a beam of sunlight for producing distant effects without the use of lenses. Two similarly-perforated disks are employed, one of which is set in rapid rotation, while the other remains stationary. This form of inter-

rupter is also admirably adapted for work with artificial light. The receiver illustrated in the drawing consists of a parabolic reflector, in the focus of which is placed a glass vessel (A) containing lamp-black, or other sensitive substance, and connected with a hearing-tube. The beam of light is interrupted by its passage through the two slotted disks shown at B, and in operating the instrument musical signals like the dots and dashes of the Morse alphabet are produced from the sensitive receiver (A) by slight motions of the mirror (C) about its axis (D).

In place of the parabolic reflector shown in the figure a conical reflector like that recommended by Prof. Sylvanus Thompson* can be used, in which case a cylindrical glass vessel would be preferable to the flask (A) shown in the figure.

In regard to the sensitive materials that can be employed, our experiments indicate that in the case of solids the physical condition and the color are two conditions that markedly influence the intensity of the sonorous effects. *The loudest sounds are produced from substances in a loose, porous, spongy condition, and from those that have the darkest or most absorbent colors.*

The materials from which the best effects have been produced are cotton-wool, worsted, fibrous materials generally, cork, sponge, platinum and other metals in a spongy condition, and lamp-black.

The loud sounds produced from such substances may perhaps be explained in the following manner: Let us consider, for example, the case of lamp-black—a substance which becomes heated by exposure to rays of all refrangibility. I look upon a mass of this substance as a sort of sponge, with its pores filled with air instead of water. When a beam of sunlight falls upon this mass, the particles of lamp-black are heated, and consequently expand, causing a contraction of the air-spaces or pores among them.

Under these circumstances a pulse of air should be expelled, just as we would squeeze out water from a sponge.

The force with which the air is expelled must be greatly increased by the expansion of the air itself, due to contact with the heated particles of lamp-black. When the light is cut off the converse process takes place. The lamp-black particles cool and contract, thus enlarging the air spaces among them, and the enclosed air also becomes cool. Under these circumstances a partial vacuum should

* Phil. Mag., April, 1881, vol. xi, p. 286.

be formed among the particles, and the outside air would then be absorbed, as water is by a sponge when the pressure of the hand is removed.

I imagine that in some such manner as this a wave of condensation is started in the atmosphere each time a beam of sunlight falls upon lamp-black, and a wave of rarefaction is originated when the light is cut off. *We can thus understand how it is that a substance like lamp-black produces intense sonorous vibrations in the surrounding air, while at the same time it communicates a very feeble vibration to the diaphragm or solid bed upon which it rests.*

This curious fact was independently observed in England by Mr. Preece, and it led him to question whether, in our experiments with thin diaphragms, the sound heard was due to the vibration of the disk or (as Prof. Hughes had suggested) to the expansion and contraction of the air in contact with the disk confined in the cavity behind the diaphragm. In his paper read before the Royal Society on the 10th of March, Mr. Preece describes experiments from which he claims to have proved that the effects are wholly due to the vibrations of the confined air, and that the *disks do not vibrate at all.*

I shall briefly state my reasons for disagreeing with him in this conclusion:

1. When an intermittent beam of sunlight is focussed upon a sheet of hard rubber or other material, a musical tone can be heard, not only by placing the ear immediately behind the part receiving the beam, but by placing it against any portion of the sheet, even though this may be a foot or more from the place acted upon by the light.

2. When the beam is thrown upon the diaphragm of a "Blake Transmitter," a loud musical tone is produced by a telephone connected in the same galvanic circuit with the carbon button, (A,) Fig. 4. Good effects are also produced when the carbon button (A) forms, with the battery, (B,) a portion of the primary circuit of an induction coil, the telephone (C) being placed in the secondary circuit.

In these cases the wooden box and mouth-piece of the transmitter should be removed, so that no air-cavities may be left on either side of the diaphragm.

It is evident, therefore, that in the case of thin disks a real vibration of the diaphragm is caused by the action of the intermittent beam, in-

dependently of any expansion and contraction of the air confined in the cavity behind the diaphragm.

Lord Rayleigh has shown mathematically that a two-and-fro vibration of sufficient amplitude to produce an audible sound would result from a periodical communication and abstraction of heat, and he says: "We may conclude, I think, that there is at present no reason for discarding the obvious explanation that the sounds in question are due to the bending of the plates under unequal heating." (Nature, xxiii, p. 274.) Mr. Preece, however, seeks to prove that the sonorous effects cannot be explained upon this supposition; but his experimental proof is inadequate to support his conclusion. Mr. Preece expected that if Lord Rayleigh's explanation was correct, the expansion and contraction of a thin strip under the influence of an intermittent beam could be caused to open and close a galvanic circuit, so as to produce a musical tone from a telephone in the circuit. But this was an inadequate way to test the point at issue, for Lord Rayleigh has shown (Proc. of Roy. Soc., 1877,) that an audible sound can be produced by a vibration, whose amplitude is *less than a ten-millionth of a centimetre*, and certainly such a vibration as that would not have sufficed to operate a "make-and-break contact" like that used by Mr. Preece. The negative results obtained by him cannot, therefore, be considered conclusive.

The following experiments (devised by Mr. Tainter) have given results decidedly more favorable to the theory of Lord Rayleigh than to that of Mr. Preece:

1. A strip (A) similar to that used in Mr. Preece's experiment was attached firmly to the centre of an iron diaphragm, (B,) as shown in Figure 5, and was then pulled taut at right angles to the plane of the diaphragm. When the intermittent beam was focussed upon the strip (A) a clear musical tone could be heard by applying the ear to the hearing tube (C,)

This seemed to indicate a rapid expansion and contraction of the substance under trial.

But a vibration of the diaphragm (B) would also have resulted if the thin strip (A) had acquired a to-and-fro motion, due either to the direct impact of the beam or to the sudden expansion of the air in contact with the strip.

2. To test whether this had been the case an additional strip (D)

was attached by its central point only to the strip under trial, and was then submitted to the action of the beam, as shown in Fig. 6.

It was presumed that if the vibration of the diaphragm (B) had been due to a *pushing force* acting on the strip (A,) the addition of the strip (D) would not interfere with the effect. But if, on the other hand, it had been due to the longitudinal expansion and contraction of the strip, (A,) the sound would cease, or, at least, be reduced. The beam of light falling upon strip (D) was now interrupted as before by the rapid rotation of a perforated disk, which was allowed to come gradually to rest.

No sound was heard excepting at a certain speed of rotation, when a feeble musical tone became audible.

This result is confirmatory of the first.

The audibility of the effect at a particular rate of interruption suggests the explanation that the strip (D) had a normal rate of vibration of its own.

When the frequency of the interruption of the light corresponded to this, the strip was probably thrown into vibration after the manner of a tuning fork, in which case a to-and-fro vibration would be propagated down its stem or central support to the strip (A.)

This indirectly proves the value of the experiment.

The list of solid substances that have been submitted to experiment in my laboratory is too long to be quoted here, and I shall merely say that we have not yet found one solid body that has failed to become sonorous under proper conditions of experiment.*

Experiments with Liquids.

The sounds produced by liquids are much more difficult to observe than those produced by solids. The high absorptive power possessed by most liquids would lead one to expect intense vibrations from the action of intermittent light, but the number of sonorous liquids that have so far been found is extremely limited, and the sounds produced are so feeble as to be heard only by the greatest attention and under the best circumstances of experiment.

* Carbon and thin microscopic glass are mentioned in my Boston paper as non-responsive, and powdered chlorate of potash in the communication to the French Academy, (Comtes Rendus, vol. xcl, p. 595.) All these substances have since yielded sounds under more careful conditions of experiment.

In the experiments made in my laboratory a very long test-tube was filled with the liquid under examination, and a flexible rubber-tube was slipped over the mouth far enough down to prevent the possibility of any light reaching the vapor above the surface. Precautions were also taken to prevent reflection from the bottom of the test-tube. An intermittent beam of sunlight was then focussed upon the liquid in the middle portion of the test-tube by means of a lens of large diameter.

Results.

Clear water	No sound audible.
Water discolored by ink	Feeble sound.
Mercury	No sound heard.
Sulphuric ether *	Feeble, but distinct sound.
Ammonia	" "
Ammonia-sulphate of copper	" "
Writing ink	" "
Indigo in sulphuric acid	" "
Chloride of copper *	" "

The liquids distinguished by an asterisk gave the best sounds.

Acoustic vibrations are always much enfeebled in passing from liquids to gases, and it is probable that a form of experiment may be devised which will yield better results by communicating the vibrations of the liquid to the ear through the medium of a solid rod.

Experiments with Gaseous Matter.

On the 29th of November, 1880, I had the pleasure of showing to Prof. Tyndall, in the laboratory of the Royal Institution, the experiments described in the letter to Mr. Tainter from which I have quoted above, and Prof. Tyndall at once expressed the opinion that the sounds were due to rapid changes of temperature in the body submitted to the action of the beam. Finding that no experiments had been made at that time to test the sonorous properties of different gases, he suggested filling one test-tube with the vapor of sulphuric ether, (a good absorbent of heat,) and another with the vapor of bi-sulphide of carbon, (a poor absorbent,) and he predicted that if any sound was heard it would be louder in the former case than in the latter.

The experiment was immediately made, and the result verified the prediction.

Since the publication of the memoirs of Röntgen* and Tyndall† we have repeated these experiments, and have extended the inquiry to a number of other gaseous bodies, obtaining in every case similar results to those noted in the memoirs referred to.

The vapors of the following substances were found to be highly sonorous in the intermittent beam: Water vapor, coal gas, sulphuric ether, alcohol, ammonia, amylene, ethyl bromide, diethylamine, mercury, iodine, and peroxide of nitrogen. The loudest sounds were obtained from iodine and peroxide of nitrogen.

I have now shown that sounds are produced by the direct action of intermittent sunlight from substances in every physical condition, (solids, liquid, and gaseous,) and the probability is therefore very greatly increased that sonorousness under such circumstances will be found to be a universal property of matter.

Upon Substitutes for Selenium in Electrical Receivers.

At the time of my communication to the American Association the loudest effects obtained were produced by the use of selenium, arranged in a cell of suitable construction, and placed in a galvanic circuit with a telephone. Upon allowing an intermittent beam of sunlight to fall upon the selenium a musical tone of great intensity was produced from the telephone connected with it.

But the selenium was very inconstant in its action. It was rarely, if ever, found to be the case, that two pieces of selenium (even of the same stick) yielded the same results under identical circumstances of annealing, &c. While in Europe last autumn, Dr. Chichester Bell, of University College, London, suggested to me that this inconstancy of result might be due to chemical impurities in the selenium used. Dr. Bell has since visited my laboratory in Washington, and has made a chemical examination of the various samples of selenium I had collected from different parts of the world. As I understand it to be his intention to publish the results of this analysis very soon, I shall make no further mention of his investigation than to state that he has found sulphur, iron, lead, and arsenic in the so-called "selenium," with traces of organic matter; that a quantitative examination has revealed the fact that sulphur constitutes nearly one per cent. of the whole mass; and that when

* Ann. der Phys. und Chem., 1881, No. 1, p. 155.

† Proc. Roy. Soc., vol. xxxi, p. 307.

these impurities are eliminated the selenium appears to be more constant in its action and more sensitive to light.

Prof. W. G. Adams* has shown that tellurium, like selenium, has its electrical resistance affected by light, and we have attempted to utilize this substance in place of selenium. The arrangement of cell (shown in Fig. 7) was constructed for this purpose in the early part of 1880; but we failed at that time to obtain any indications of sensitiveness with a reflecting galvanometer. We have since found, however, that when this tellurium spiral is connected in circuit with a galvanic battery and telephone, and exposed to the action of an intermittent beam of sunlight, a distinct musical tone is produced by the telephone. The audible effect is much increased by placing the tellurium cell with the battery in the primary circuit of an induction coil, and placing the telephone in the secondary circuit.

The enormously high resistance of selenium and the extremely low resistance of tellurium suggested the thought that an alloy of these two substances might possess intermediate electrical properties. We have accordingly mixed together selenium and tellurium in different proportions, and, while we do not feel warranted at the present time in making definite statements concerning the results, I may say that such alloys have proved to be sensitive to the action of light.

It occurred to Mr. Tainter before my return to Washington last January, that the very great molecular disturbance produced in lamp-black by the action of the intermittent sunlight should produce a corresponding disturbance in an electric current passed through it, in which case lamp-black could be employed in place of selenium in an electrical receiver. This has turned out to be the case, and the importance of the discovery is very great, especially when we consider the expense of such rare substances as selenium and tellurium.

The form of lamp-black cell we have found most effective is shown in Fig. 8. Silver is deposited upon a plate of glass, and a zigzag line is then scratched through the film, as shown, dividing the silver surface into two portions insulated from one another, having the form of two combs with interlocking teeth.

Each comb is attached to a screw-cup, so that the cell can be

* Proc. Roy. Soc., vol. xxiv, p. 163.

placed in an electrical circuit when required. The surface is then smoked until a good film of lamp-black is obtained, filling the interstices between the teeth of the silver combs. When the lamp-black cell is connected with a telephone and galvanic battery, and exposed to the influence of an intermittent beam of sunlight, a loud musical tone is produced by the telephone. This result seems to be due rather to the physical condition than to the nature of the conducting material employed, as metals in a spongy condition produce similar effects. For instance, when an electrical current is passed through spongy platinum, while it is exposed to intermittent sunlight, a distinct musical tone is produced by a telephone in the same circuit. In all such cases the effect is increased by the use of an induction coil; and the sensitive cells can be employed for the reproduction of an articulate speech as well as for the production of musical sounds.

We have also found that loud sounds are produced from lamp-black by passing through it an intermittent electrical current; and that it can be used as a telephonic receiver for the reproduction of articulate speech by electrical means.

A convenient mode of arranging a lamp-black cell for experimental purposes is shown in Fig. 9. When an intermittent current is passed through the lamp-black, (A,) or when an intermittent beam of sunlight falls upon it through the glass plate B, a loud musical tone can be heard by applying the ear to the hearing-tube C. When the light and the electrical current act simultaneously, two musical tones are perceived, which produce beats when nearly of the same pitch. By proper arrangements a complete interference of sound can undoubtedly be produced.

Upon the Measurement of the Sonorous Effects produced by Different Substances.

We have observed that different substances produce sounds of very different intensities under similar circumstances of experiment, and it has appeared to us that very valuable information might be obtained if we could measure the audible effects produced. For this purpose we have constructed several different forms of apparatus for studying the effects, but as our researches are not yet complete, I shall confine myself to a simple description of some of the forms of apparatus we have devised.

When a beam of light is brought to a focus by means of a lens, the beam diverging from the focal point becomes weaker as the distance increases in a calculable degree. Hence, if we can determine the distances from the focal point at which two different substances emit sounds of equal intensity, we can calculate their relative sonorous powers.

Preliminary experiments were made by Mr. Tainter during my absence in Europe to ascertain the distance from the focal point of a lens at which the sound produced by a substance became inaudible. A few of the results obtained will show the enormous differences existing between the different substances in this respect.

Distance from Focal Point of Lens at which Sounds became Inaudible with Different Substances.

Zinc diaphragm, (polished)-----	1.51 m.
Hard rubber diaphragm-----	1.90 m.
Tin-foil "-----	2.00 m.
Telephone " (Japanned iron)-----	2.15 m.
Zinc " (unpolished)-----	2.15 m.
White silk, (In receiver shown in Fig. 1.)-----	3.10 m.
White worsted, " " "-----	4.01 m.
Yellow worsted, " " "-----	4.06 m.
Yellow silk, " " "-----	4.13 m.
White cotton-wool, " " "-----	4.38 m.
Green silk, " " "-----	4.52 m.
Blue worsted, " " "-----	4.69 m.
Purple silk, " " "-----	4.82 m.
Brown silk, " " "-----	5.02 m.
Black silk, " " "-----	5.21 m.
Red silk, " " "-----	5.24 m.
Black worsted, " " "-----	6.50 m.
Lamp-black. In this case the limit of audibility could not be determined on account of want of space.	
Sound perfectly audible at a distance of-----	10.00 m.

Mr. Tainter was convinced from these experiments that this field of research promised valuable results, and he at once devised an apparatus for studying the effects, which he described to me upon my return from Europe. The apparatus has since been constructed and I take great pleasure in showing it to you to-day.

(1.) A beam of light is received by two similar lenses, (A B, Fig. 10,) which brings the light to a focus on either side of the

interrupting disk (C.) The two substances, whose sonorous powers are to be compared, are placed in the receiving vessels (D E) (so arranged as to expose equal surfaces to the action of the beam) which communicate by flexible tubes (F G) of equal length, with the common hearing-tube (H.) The receivers (D E) are placed upon slides, which can be moved along the graduated supports (I K.) The beams of light passing through the interrupting disk (C) are alternately cut off by the swinging of a pendulum, (L.) Thus a musical tone is produced alternately from the substance in D and from that in E. One of the receivers is kept at a constant point upon its scale, and the other receiver is moved towards or from the focus of its beam until the ear decides that the sounds produced from D and E are of equal intensity. The relative positions of the receivers are then noted.

(2.) Another method of investigation is based upon the production of an interference of sound, and the apparatus employed is shown in Fig. 11. The interrupter consists of a tuning-fork, (A,) which is kept in continuous vibration by means of an electro-magnet, (B.)

A powerful beam of light is brought to a focus between the prongs of the tuning-fork, (A,) and the passage of the beam is more or less obstructed by the vibration of the opaque screens (C D) carried by the prongs of the fork.

As the tuning-fork (A) produces a sound by its own vibration, it is placed at a sufficient distance away to be inaudible through the air, and a system of lenses is employed for the purpose of bringing the undulating beam of light to the receiving lens (E) with as little loss as possible. The two receivers (F G) are attached to slides (H I) which move upon opposite sides of the axis of the beam, and the receivers are connected by flexible tubes of unequal length (K L) communicating with the common hearing-tube (M.)

The length of the tube (K) is such that the sonorous vibrations from the receivers (F G) reach the common hearing-tube (M) in opposite phases. Under these circumstances silence is produced when the vibrations in the receivers (F G) are of equal intensity. When the intensities are unequal, a residual effect is perceived. In operating the instrument the position of the receiver (G) remains constant, and the receiver (F) is moved to or from the focus of the beam until complete silence is produced. The relative positions of the two receivers are then noted.

(3.) Another mode is as follows: The loudness of a musical tone produced by the action of light is compared with the loudness of a tone of similar pitch produced by electrical means. A rheostat introduced into the circuit enables us to measure the amount of resistance required to render the electrical sound equal in intensity to the other.

(4.) If the tuning-fork (A) in Fig. 11 is thrown into vibration by an undulatory instead of an intermittent current passed through the electro-magnet, (B,) it is probable that a musical tone, electrically produced in the receiver (F) by the action of the same current, would be found capable of extinguishing the effect produced in the receiver (G) by the action of the undulatory beam of light, in which case it should be possible to establish an acoustic balance between the effects produced by light and electricity by introducing sufficient resistance into the electric circuit.

Upon the Nature of the Rays that Produce Sonorous Effects in Different Substances.

In my paper read before the American Association last August and in the present paper I have used the word "light" in its usual rather than its scientific sense, and I have not hitherto attempted to discriminate the effects produced by the different constituents of ordinary light, the thermal, luminous, and actinic rays. I find, however, that the adoption of the word "photophone" by Mr. Tainter and myself has led to the assumption that we believed the audible effects discovered by us to be due entirely to the action of luminous rays. The meaning we have uniformly attached to the words "photophone" and "light" will be obvious from the following passage, quoted from my Boston paper:

"Although effects are produced as above shown by forms of radiant energy, which are invisible, we have named the apparatus for the production and reproduction of sound in this way the 'photophone' because an ordinary beam of light contains the rays which are operative."

To avoid in future any misunderstanding upon this point we have decided to adopt the term "*radiophone*," proposed by Mr. Mercadier, as a general term signifying an apparatus for the production of sound by any form of radiant energy, limiting the words *thermophone*, *photophone*, and *actinophone* to apparatus for the production of sound by thermal, luminous, or actinic rays respectively.

M. Mercadier, in the course of his researches in radiophony, passed an intermittent beam from an electric lamp through a prism, and then examined the audible effects produced in different parts of the spectrum. (*Comptes Rendus*, Dec. 6th, 1880.)

We have repeated this experiment, using the sun as our source of radiation, and have obtained results somewhat different from those noted by M. Mercadier.

(1.) A beam of sunlight was reflected from a heliostat (A, Fig. 12) through an achromatic lens, (B,) so as to form an image of the sun upon the slit (C.)

The beam then passed through another achromatic lens (D) and through a bisulphide of carbon prism, (E,) forming a spectrum of great intensity, which, when focused upon a screen, was found to be sufficiently pure to show the principal absorption lines of the solar spectrum.

The disk interrupter (F) was then turned with sufficient rapidity to produce from five to six hundred interruptions of the light per second, and the spectrum was explored with the receiver, (G,) which was so arranged that the lamp-black surface exposed was limited by a slit, as shown.

Under these circumstances sounds were obtained in every part of the visible spectrum, excepting the extreme half of the violet, as well as in the ultra-red. A continuous increase in the loudness of the sound was observed upon moving the receiver (G) gradually from the violet into the ultra-red. The point of maximum sound lay very far out in the ultra-red. Beyond this point the sound began to increase, and then stopped so suddenly that a very slight motion of the receiver (G) made all the difference between almost maximum sound and complete silence.*

(2.) The lamp-black wire gauze was then removed and the interior of the receiver (G) was filled with red worsted. Upon exploring the spectrum as before, entirely different results were obtained. The maximum effect was produced in the green at that part where the red worsted appeared to be black. On either side of this point the sound gradually died away, becoming inaudible on the one side in the middle of the indigo, and on the other at a short distance outside the edge of the red.

* The results obtained in this and subsequent experiments are shown in a tabulated form in Fig. 14.

(3.) Upon substituting green silk for red worsted, the limits of audition appeared to be the middle of the blue and a point a short distance out in the ultra-red. Maximum in the red.

(4.) Some hard-rubber shavings were now placed in the receiver (G.) The limits of audibility appeared to be on the one hand the junction of the green and blue, and on the other the outside edge of the red. Maximum in the yellow. Mr. Tainter thought he could hear a little way into the ultra-red, and to his ear the maximum was about the junction of the red and orange.

(5.) A test-tube containing the vapor of sulphuric ether was then substituted for the receiver (G.) Commencing at the violet end the test-tube was gradually moved down the spectrum and out into the ultra-red without audible effect, but when a certain point far out in the ultra-red was reached, a distinct musical tone suddenly made its appearance, which disappeared as suddenly on moving the test-tube a very little further on.

(6.) Upon exploring the spectrum with a test-tube containing the vapor of iodine, the limits of audibility appeared to be the middle of the red and the junction of the blue and indigo. Maximum in the green.

(7.) A test-tube containing peroxide of nitrogen was substituted for that containing iodine. Distinct sounds were obtained in all parts of the visible spectrum, but no sounds were observed in the ultra-red. The maximum effect seemed to me to be in the blue. The sounds were well marked in all parts of the violet, and I even fancied that the audible effect extended a little way into the ultra-violet, but of this I cannot be certain. Upon examining the absorption spectrum of peroxide of nitrogen it was at once observed that the maximum sound was produced in that part of the spectrum where the greatest number of absorption lines made their appearance.

(8.) The spectrum was now explored by a selenium cell, and the audible effects were observed by means of a telephone in the same galvanic circuit with the cell. The maximum effect was produced in the red about its junction with the orange. The audible effect extended a little way into the ultra-red on the one hand and up as high as the middle of the violet on the other.

Although the experiments so far made can only be considered as preliminary to others of a more refined nature, I think we are warranted in concluding that *the nature of the rays that produce sonorous effects in different substances depends upon the nature of the*

substances that are exposed to the beam, and that the sounds are in every case due to those rays of the spectrum that are absorbed by the body.

The Spectrophone.

Our experiments upon the range of audibility of different substances in the spectrum have led us to the construction of a new instrument for use in spectrum analysis. The eye-piece of a spectroscope is removed, and sensitive substances are placed in the focal point of the instrument behind an opaque diaphragm containing a slit. These substances are put in communication with the ear by means of a hearing-tube, and thus the instrument is converted into a veritable "spectrophone," like that shown in Fig. 13.

Suppose we smoke the interior of our spectrophone receiver, and fill the cavity with peroxide of nitrogen gas. We have then a combination that gives us good sounds in all parts of the spectrum, (visible and invisible,) except the ultra-violet. Now, pass a rapidly-interrupted beam of light through some substance whose absorption spectrum is to be investigated, and bands of sound and silence are observed upon exploring the spectrum, the silent positions corresponding to the absorption bands. Of course, the ear cannot for one moment compete with the eye in the examination of the visible part of the spectrum; but in the invisible part beyond the red, where the eye is useless, the ear is invaluable. In working in this region of the spectrum, lamp-black alone may be used in the spectrophonic receiver. Indeed, the sounds produced by this substance in the ultra-red are so well marked as to constitute our instrument a most reliable and convenient substitute for the thermo-pile. A few experiments that have been made may be interesting.

(1.) The interrupted beam was filtered through a saturated solution of alum.

Result: The range of audibility in the ultra-red was slightly reduced by the absorption of a narrow band of the rays of lowest refrangibility. The sounds in the visible part of the spectrum seemed to be unaffected.

(2.) A thin sheet of hard rubber was interposed in the path of the beam.

Result: Well-marked sounds in every part of the ultra-red. No

sounds in the visible part of the spectrum, excepting the extreme half of the red.

These experiments reveal the cause of the curious fact alluded to in my paper read before the American Association last August—that sounds were heard from selenium when the beam was filtered through both hard rubber and alum at the same time. (See table of results in Fig. 14.)

(3.) A solution of ammonia-sulphate of copper was tried.

Result: When placed in the path of the beam the spectrum disappeared, with the exception of the blue and violet end. To the eye the spectrum was thus reduced to a single broad band of blue-violet light. To the ear, however, the spectrum revealed itself as two bands of sound with a broad space of silence between. The invisible rays transmitted constituted a narrow band just outside the red.

I think I have said enough to convince you of the value of this new method of examination, but I do not wish you to understand that we look upon our results as by any means complete. It is often more interesting to observe the first totterings of a child than to watch the firm tread of a full-grown man, and I feel that *our* first footsteps in this new field of science may have more of interest to you than the fuller results of mature research. This must be my excuse for having dwelt so long upon the details of incomplete experiments.

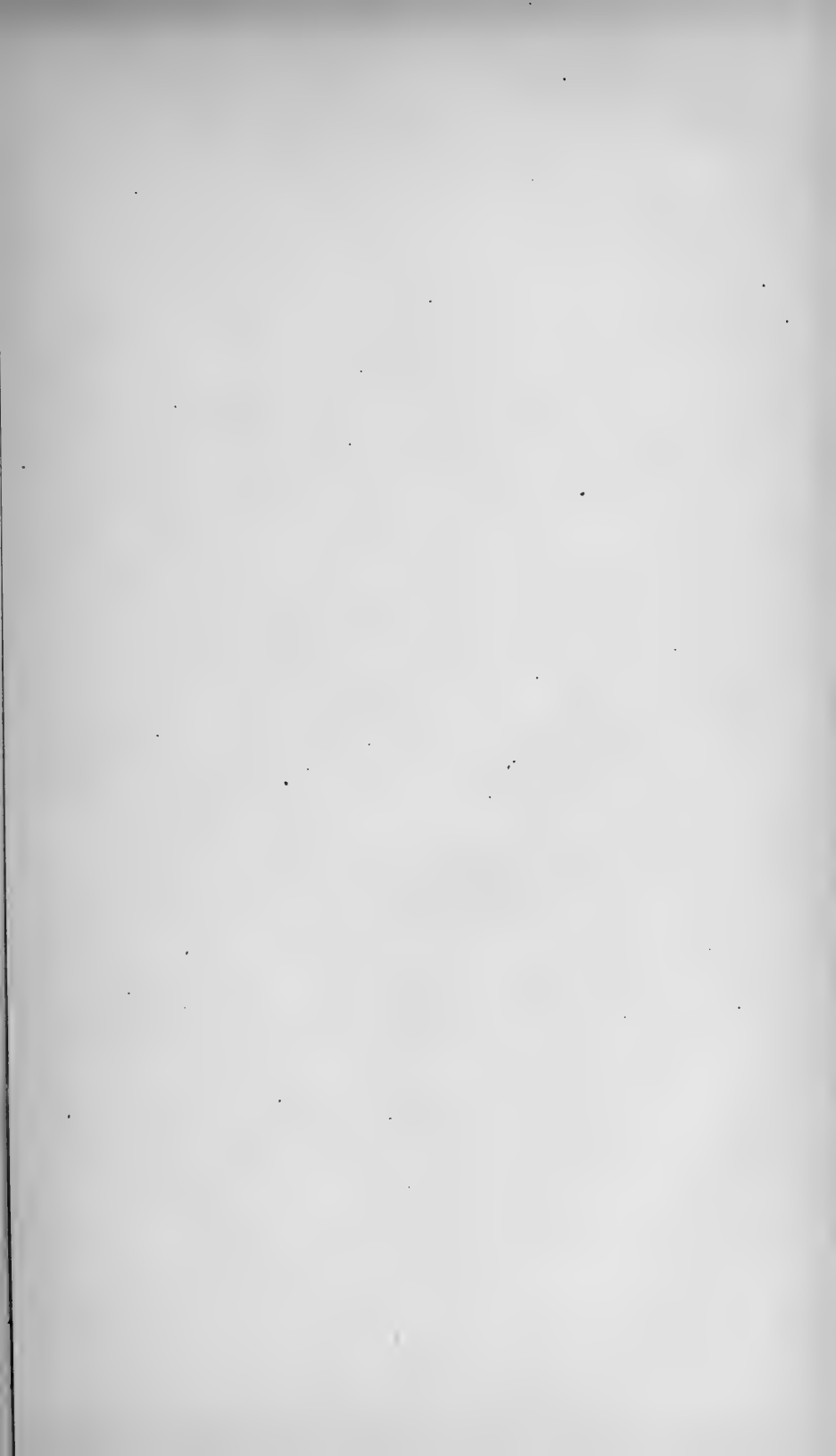
I recognize the fact that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra-red.

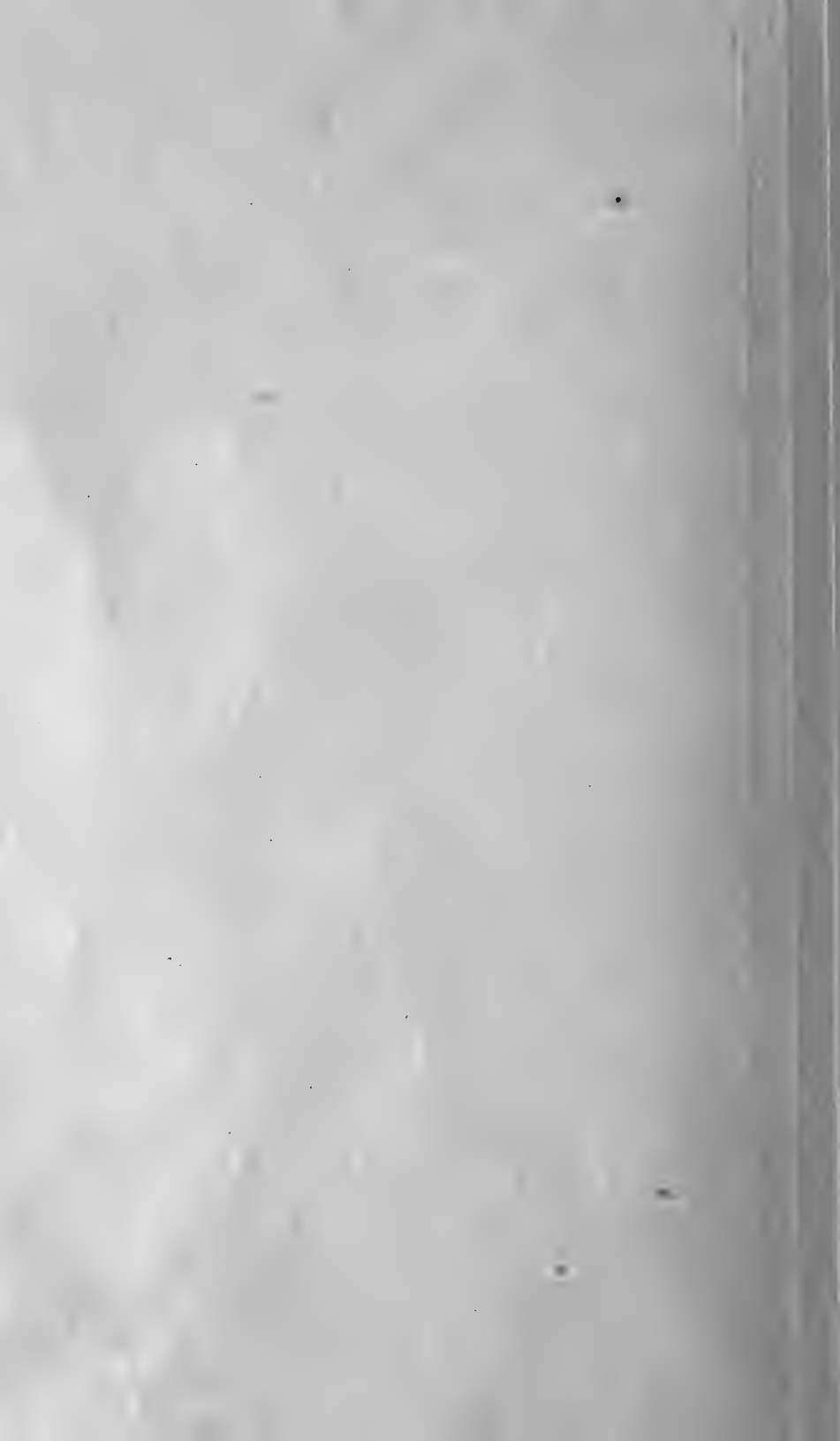
Mr. WM. B. TAYLOR inquired whether the sounds obtained from the two absorption bands of the ammonia-sulphate of copper were octaves of each other. Mr. BELL replied that this matter had not as yet been investigated.

Prof. WILLIAM B. ROGERS, President of the National Academy of Sciences, being present as an invited guest, paid a high tribute to Mr. Bell upon the very great interest and high scientific value of the discovery just announced.

The next communication was by Mr. G. BROWN GOODE on the

SWORD-FISH AND ITS ALLIES.





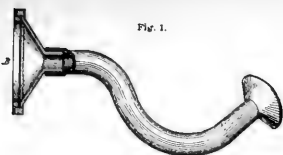


Fig. 1.



Fig. 2.



Fig. 3.

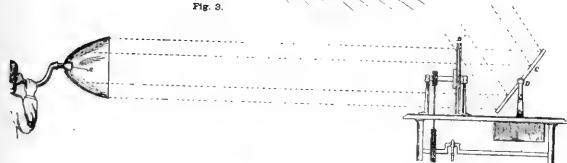


Fig. 4.

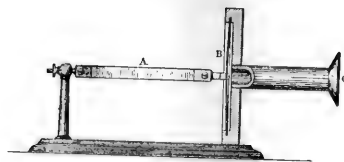
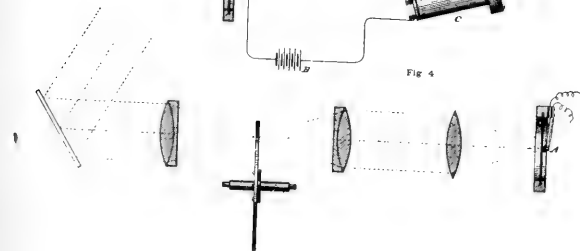
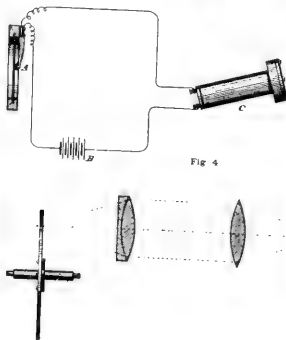


Fig. 7.

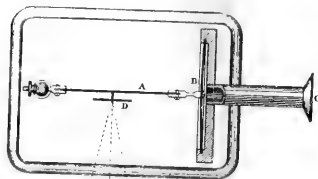


Fig. 8.

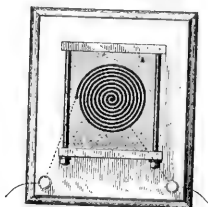


Fig. 9.

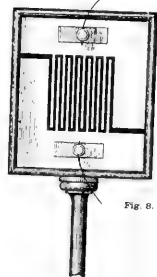


Fig. 10.

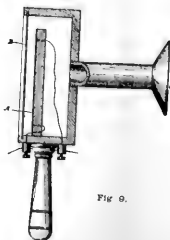


Fig. 11.

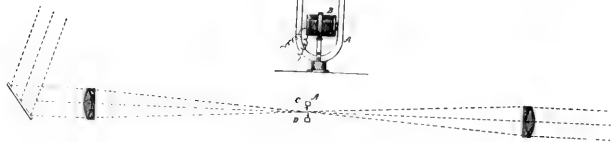


Fig. 12.

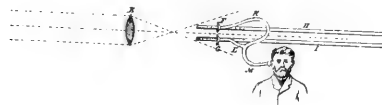


Fig. 13.

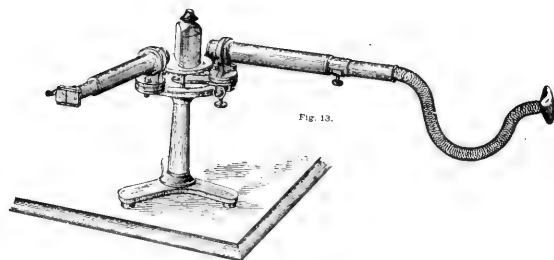
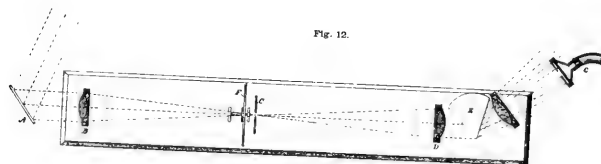


Fig. 15.

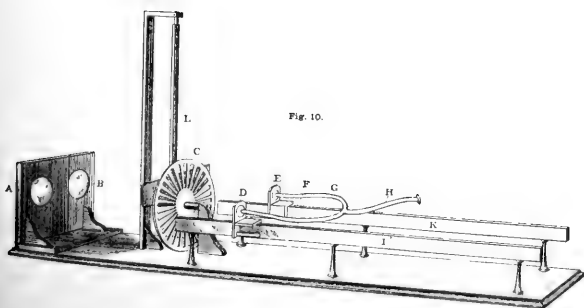
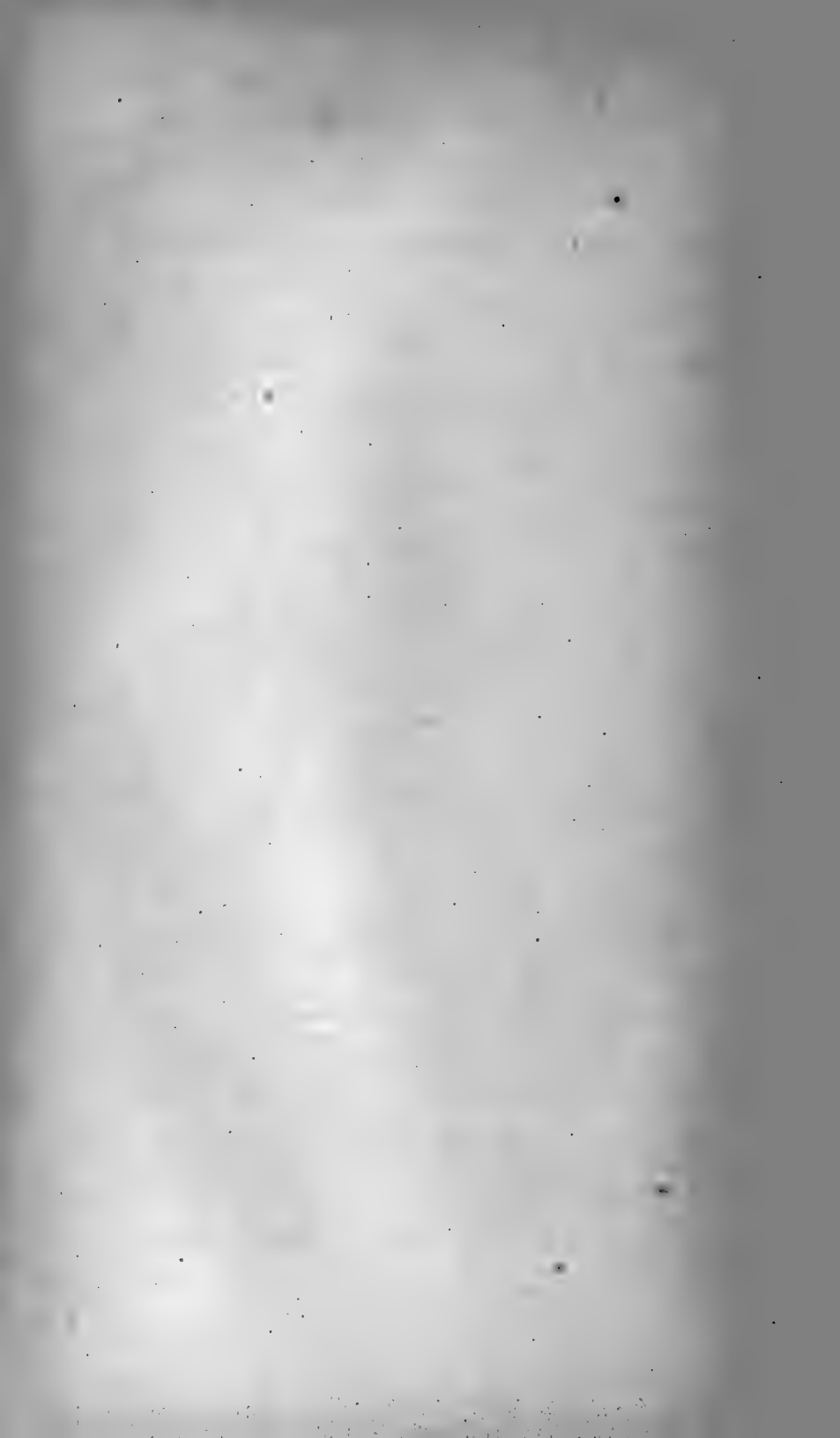


Fig. 16.

Fig. 14.

122	36	27	27	26	28	27	103	
Ultra Red.	Red	Orange Yellow	Green	Blue	Indigo	Violet.	Ultra Violet.	
	Transparency							
	Red Viscous							
	Green Silk							
	Hard Rubber							
	Thin Paper of Sulphuric Ether.							
	Tobacco Vapor							
	Deposits of Nitrogen							
	Mercuric							
	Absorption by Glass							
	Absorption by Hard Rubber							
	Absorption by Sulphuric Ether							



This paper will be found published in full in the Annual Report of the United States Fish Commission for the year 1880.

At the conclusion of Mr. GOODE's paper the Society adjourned.

199TH MEETING.

APRIL 30, 1881.

The President in the chair.

Forty-eight members present.

The recorder of the minutes of the last meeting being absent their consideration was postponed.

Mr. W. H. DALL made a communication on

RECENT DISCOVERIES IN ALASKA NORTH OF BEHRING STRAIT, in which he alluded to the investigations carried on by the U. S. R. S. Corwin, Capt. Hooper, during the summer of 1880, including meteorology, sea temperatures and currents, as well as the investigation of the coal mines near Cape Lisburne. He described some observations made by the U. S. Coast Survey party under his charge in the same region and season, on board the U. S. S. Yukon. The migration of the Asiatic Eskimo; the sources of the warm waters of the eastern half of Behring Strait in Kotzebue and Norton Sound waters, moved by the tidal and river flow; the existence of a supposed new species of sheep allied to the Rocky Mountain bighorn (*Ovis montana*) in the east Siberian peninsula, and the character of Arctic vegetations were spoken of. Reasons for doubting the truth of the account of an alleged landing on Wrangell Land, in 1866, described in the Bremen Geographical Society's publication by a Capt. Dallmann were brought forward, and it was pointed out that the existence of Plover Island, of Siberian musk-oxen, and of certain conditions of the ice alleged by Dallmann, were in conflict with all that is definitely known by scientific men of those matters.

Remarks upon this paper were made by Messrs. ANTISELL, WHITE, FARQUHAR, HARKNESS, ALVORD, MASON, HAZEN, WELLING, ABBE, BESSELS, and GILL.

Mr. J. S. BILLINGS commenced a paper on Mortality Statistics

of the Tenth Census, but at the usual hour of adjournment it was interrupted, to be resumed at the following meeting.

The Society then adjourned.

200TH MEETING.

MAY 14, 1881.

The President in the Chair.

Thirty-six members present.

The minutes of the last two meetings were read and adopted.

The first communication of the evening was the continuation by Mr. J. S. BILLINGS of his remarks upon

MORTALITY STATISTICS OF THE TENTH CENSUS.

[Abstract.]

Mr. J. S. BILLINGS described the methods used in the Tenth Census to secure completeness and accuracy in the returns of mortality. The Superintendent of the Census sought to secure the aid of the physicians of the country, and for this purpose sent to each a small blank book, each leaf of which was arranged to record the facts connected with a single death. 70,306 such books were issued, and 24,057 returned at the end of the census year. The data from these books were compiled by causes of death, age, and sex, and the slips were then used to complete the enumerator's schedules. The total number of deaths reported from all sources for the census year will be a little over 800,000, or about 16 per 1,000 of living population, being an improvement in completeness over previous censuses. The results of the attempt to record the number sick on the day of the census are not very satisfactory, and it is feared they will be too incomplete to be used. Taking the schedules for the State of Rhode Island, which are believed to be the most complete, it is found that the number reported sick on the 30th of June was 11.18 per 1,000 of the whole population.

It is usual to estimate two years of sickness to each death, which would make the number constantly sick range from 30 to 40 per 1,000. In the army for five years the proportion was 43 per 1,000.

It seems probable that, while the proportion of sick shown by the Rhode Island count is too low, it is more nearly correct than any other data which we possess.

Mr. BILLINGS continued his remarks upon the Methods of the Tenth Census, and described the methods of compiling the mortality statistics and the forms of tables to be used. The importance of these forms is greater than usual since they will probably serve to a certain extent as models for the State Censuses of 1885. The want of uniformity in tables of mortality was shown by a chart in which the various forms were compared. The various items given in a return of death, viz., sex, age, color, civil condition, nativity, parentage, occupation, month of death, locality and cause of death, were commented on, and it was shown that to present all these facts in their various relations, would require several hundred quarto volumes. A selection, therefore, becomes necessary. The relative value of giving the causes of death in detail is very much less in tables to be prepared from the enumerator's schedules than in those prepared from the returns of a system of registration where the cause of death in each case has been certified to by a physician.

The importance of a proper tabulation by locality is very great, and a certain amount of data should be given by counties. A form of mortality return by counties was shown and explained. The distinction between nativity and race or parentage was explained, and great importance attached to the giving the parentage as fully as possible in the present census.

The modes of compiling by schedule sheets, by cards, and by tallying machines were then explained. The subject of life tables for the United States was briefly discussed—the ground being taken that such a table for the whole country would have little or no practical value, and that life tables by States would be much more desirable and important.

Remarks were made on this paper by Messrs. MASON, ANTISELL, TONER, and HARKNESS.

The communication was followed by one from Mr. S. C. BUSEY, on the

RELATION OF METEOROLOGICAL CONDITIONS TO THE SUMMER
DIARRHOEAL DISEASES.

[Abstract. The paper will be found in Vol. 32, Transactions American Medical Association.]

An analysis of the mortality statistics of these diseases leads to the following conclusions:

1. Diarrhœal diseases are far more destructive to infants than to adults.

2. They prevail almost exclusively during the warmest months of the year.

3. They are more prevalent in the region of this country north of the north line of the Gulf States and east of the Rocky Mountains.

The first two conclusions are universally admitted; the third is not so generally recognized.

Two additional propositions are suggested:

1. These diseases occur in groups, when the cases rapidly multiply during successive days for a week or fortnight, followed by an interval during which few or no cases occur.

2. These groups correspond with waves of continuous high temperature during day and night, which spread, at shorter or longer intervals during the summer months, over the northern climatic belt of this country, lasting from three to fourteen days, and varying in intensity at different times and in different years.

The first of these propositions cannot be established, because of the absence of statistical data relating to the beginning of the initial symptoms of the diseases; the second is proven by data supplied by the Signal Service Bureau. A comparison of these data with the mortality statistics shows:

1. That the month of July is the hottest and sickliest month of the year, most conducive to bowel affections, and most fatal to children under five years of age.

2. The epidemics of bowel affections of children, incident to the summer season, have their beginning nearly simultaneously with the first exacerbation of heat, which usually occurs in the latter half of June; and the maximum daily mortalities more frequently correspond with the maximum temperatures, which occur in periods of three or more days, at longer or shorter intervals during the summer months.

3. With the usual lowering of temperature and absence of ex-

cessive heat periods, which occur after the middle of August, the daily mortality declines.

4. The detrimental influence of summer temperature is intensified by sudden and acute elevations and falls.

5. Children under one year of age are most numerous and seriously affected.

Heat exhibits its deleterious influence in another and very important relation. It is one of the many conditions which, in conjunction, make up a season. A comparison of the statistics of the weekly mortality from diarrhœal diseases in the principal cities of the country grouped according to latitude, will exhibit the gradual increase of these diseases with the gradual advance of the summer solstice northward until it reaches its maximum during the period when all the elements which complete the season of summer are in their fullest activity; also a gradual decline with the return of the winter season.

The total movement of the wind is, perhaps, a more important influence than is generally believed. A comparison of the mortality data with the records of the monthly measurement of the wind, supplied by the Signal Service Bureau for the years 1875, 1876, 1877, 1878, 1879, and 1880, shows:

1. July is the month of greatest mortality and least movement of the wind.

2. The nearer the monthly movements of the wind approach uniformity, the less the mortality for summer diarrhœas.

3. Equality of climate corresponds with uniformity of and moderate or small movements of wind, and small mortalities.

4. Wide ranges of temperature correspond with large movements of wind and high mortalities from diarrhœal diseases.

5. Weekly mortalities from diarrhœal disease increase correspondingly with advance of the summer solstice northward, increasing and greater range of temperature, and larger and more fluctuating movements of wind.

Relative saturation of the air bears no constant relation to mortalities. Moisture in relative excess to the heat of an impure and stagnant atmosphere is the condition which supplies the most satisfactory explanation of its detrimental influence.

Remarks were made upon this paper by Messrs. HARKNESS, BILLINGS, and WOODWARD.

At the conclusion of this discussion the Society adjourned.

201ST MEETING.

MAY 28, 1881.

The President in the Chair.

Thirty-four members present.

The minutes of the last meeting were read and adopted.

The first communication was by Mr. D. P. TODD on

THE SOLAR PARALLAX AS DERIVED FROM THE AMERICAN PHOTOGRAPHS OF THE TRANSIT OF VENUS, 1874, DECEMBER 8-9.

In the volume of observations of the transit of Venus recently issued, the photographs are presented in very nearly the form of equations of conditions involving the corrections of the relative right ascension and declination of the sun and Venus, and the correction of the adopted value of the solar parallax. The total number of photographs is 213, of which 84 were obtained at stations in the northern hemisphere, and 129 in the southern.

Every photograph gives one equation of condition in distance, s , of the form

$$o = a \delta A + b \delta D + c \delta \omega - (o. - C.)$$

The normal equations in s are—

$$\begin{aligned} + 23.99 \delta A + 24.71 \delta D - 28.72 \delta \omega - 82.17 &= 0 \\ + 24.71 \delta A + 184.66 \delta D - 3.16 \delta \omega - 439.51 &= 0 \\ - 28.72 \delta A - 3.16 \delta D + 484.51 \delta \omega + 21.72 &= 0 \end{aligned}$$

Their solution gives—

$$\begin{aligned} \delta A &= + 1.''181 \pm 0.''202 \\ \delta D &= + 2.''225 \pm 0.''070 \\ \delta \omega &= + 0.''0397 \pm 0.''0418 \end{aligned}$$

Every photograph gives, likewise, one equation of condition in position-angle, p , of the form

$$o = a' \delta A + b' \delta D + c' \delta \omega - (o'. - C'.)$$

The normal equations in p are—

$$\begin{aligned} + 8682117 \delta A - 1404261 \delta D - 138999.20 \delta \omega - 142109.4 &= 0 \\ - 1404261 \delta A + 1521370 \delta D - 25093.11 \delta \omega + 10442.1 &= 0 \\ - 138999.20 \delta A + 25093.11 \delta D + 7326.76 \delta \omega + 2651.6 &= 0 \end{aligned}$$

Their solution gives—

$$\delta A = + 1.''109 \pm 0.''109$$

$$\delta D = + 0.''637 \pm 0.''224$$

$$\delta \omega = + 0.''0252 \pm 0.''0595$$

Combining these values of δA , δD , and $\delta \omega$ in accordance with their probable errors, we have, finally,

$$\delta A = + 0.''075 \pm 0.''006$$

$$\delta D = + 2.''083 \pm 0.''067$$

$$\delta \omega = + 0.''035 \pm 0.''034$$

The assumed value of ω being $8.''848$, we have, therefore, for the mean equatorial horizontal parallax of the sun,

$$8.''883 \pm 0.''034,$$

corresponding to a distance between the centres of the sun and earth, equal to 92,028,000 miles.

(This paper appears in part in *The American Journal of Science* for June, 1881.)

Mr. HARKNESS remarked that the Americans who were engaged in the last transit observations may fairly congratulate themselves upon the results obtained from the photographs, as he had no doubt that they were more satisfactory and consistent than the photographic results obtained by any other nation. There may be said to be two distinct methods of obtaining photographs involving instruments differing widely from the other. The English method employed a telescope of four or five inches aperture producing an image of the sun about three-fourths of an inch in diameter. It is necessary to enlarge this image to a diameter of about four inches, and therefore they used in connection with it a Dallmeyer rapid rectilinear lens, enlarging it by that amount. It is obvious that this enlargement by the use of such a lens must be accompanied by an amount of distortion of the image, which, unless it can be accurately determined and eliminated, must introduce a serious error in the measurements of the negatives, and in the results derived from them. This distortion varies in the direction of radii from the optical center of the image, and is equal in circles about that center. Thus far the amount of this distortion has not been determined. The other method, employed by the Americans, involved the use of a lens with forty feet focal distance giving directly the required size of image, and involving no appreciable distortion inherently due to the construction of the apparatus, and thus avoided the causes of error

just described. The focal length required to be determined with great accuracy, and this was readily effected.

Another difficulty arose from the fact that the diameter of the photographic picture on the negative was liable to variation, with a varying length of exposure; and the diameter of the image of Venus is liable to an inverse variation of the same kind. If the distance between the exterior boundaries of the sun and planet were measured, this error would be liable to vitiate the result and, hence, it was necessary to find the centers of the two images, and measure the distances between these central points. Mr. HARKNESS described the method by which this was satisfactorily accomplished.

There were about twenty plates which gave anomalous results. It was obvious after trial, that the difficulty was with the plates themselves and not due to the observers, since from any one plate a number of observers obtained corresponding results.

Mr. HARKNESS then spoke of the various methods employed to ascertain the sun's parallax : 1st, by measuring the velocity of light, and the time required for light to traverse known chords of the earth's orbit; 2d, by measuring the aberration of light; 3d, by measuring the parallax of the planet Mars; and 4th, by the analysis of the motions of the moon; all of which gave results in very close agreement.

The second communication was by Mr. G. K. GILBERT on
THE ORIGIN OF THE TOPOGRAPHICAL FEATURES OF LAKE SHORES.

This communication was reserved by the author.

After remarks by Mr. ANTISELL, the Society adjourned.

202D MEETING.

JUNE 11, 1881.

The President in the Chair.

Fifty-seven members and visitors present.

The minutes of the last meeting were read and adopted.

The Chair announced to the Society that the General Committee had resolved that at the conclusion of the present meeting the Society would stand adjourned until the second Saturday in October.

The first communication of the evening was by Mr. J. J. WOODWARD, the President of the Society, entitled

A BIOGRAPHICAL SKETCH OF THE LATE DR. OTIS.

GEORGE ALEXANDER OTIS, Surgeon and Brevet Lieutenant-Colonel, United States Army, Curator of the Army Medical Museum, and Editor of the Surgical volumes of the Medical and Surgical History of the War of the Rebellion, died at Washington, D. C., February 23, 1881, at the comparatively early age of fifty years.

Surgeon Otis was descended from a cultivated New England family. His great grandfather, Ephraim Otis, was a physician who practiced at Scituate, Massachusetts. His grandfather, George Alexander Otis, was a well-known citizen of Boston, Massachusetts, whose early years were occupied by commercial pursuits. Mr. Otis was a man of education and literary tastes, who, so soon as his circumstances permitted, retired from business, and devoted himself entirely to books. He is remembered especially on account of his translation of Botta's History of the War of the Independence of the United States of America, published in 1820, an undertaking in which he was encouraged by James Madison and John Quincy Adams, and which he accomplished so well that the book ran through twelve editions. He died at an advanced age in June, 1863.

The father of Surgeon Otis, also George Alexander Otis, was born in 1804. He attended the preparatory course at the Boston Latin School, studied and graduated at Harvard College, after which he devoted himself, with much promise, to the profession of law. Mr. Otis was married February 9, 1830, to Anna Maria Hickman, of Newton, Massachusetts, daughter of Harris Hickman, a lawyer, born at Front Royal, Virginia, who had enjoyed an excellent professional reputation in early life in the Shenandoah Valley, and subsequently at Detroit, in the then Territory of Michigan. Of this marriage the subject of our biographical sketch was the only issue, Mr. Otis dying of consumption, June 18, 1831.

George Alexander Otis was born in Boston, Massachusetts, November 12, 1830. Left an infant to the tender care of his widowed mother, his early years were nurtured by a devoted love, which accompanied him through youth and manhood, smoothed the pillow of his last illness, and followed him to the grave.

When old enough to go to school, George was sent at first to the Boston Latin School, and afterwards to the Fairfax Institute, at Alexandria, Virginia, where he was prepared for college. In 1846

he entered Princeton College as a student of the sophomore class, and graduated with the degree of A. B., in 1849. Princeton conferred upon him the degree of Master of Arts in 1852.

At Princeton, Otis appeared as a slender, rather delicate youth, of highly nervous organization, whose literary tastes were not satisfied with the comparatively narrow curriculum of his Alma Mater. Always standing well in his college classes, that he did not take a still higher place was not due to lack of ability or of studious habits, but rather to his love of general literature, and the large proportion of his time expended in its cultivation. He had already acquired a fondness for French literature, which he never afterwards lost, and a taste for verse so far cultivated that when he came to graduate the Faculty assigned to him the task of preparing the commencement-day poem. Retiring and reserved in his manners, often silent and abstracted, the few who were admitted to his intimacy found his nature gentle and sympathetic, and several of the friendships he then formed lasted throughout his life.

By this time Otis had selected medicine as his profession. After leaving Princeton he went to Richmond, Virginia, where his mother was then residing, and began his studies in the office of Dr. F. H. Deane, of that city. In the fall of 1849 he proceeded to Philadelphia, and matriculated in the Medical Department of the University of Pennsylvania. That institution conferred upon him the degree of Doctor of Medicine in April, 1851. In those days the medical teachings of the University of Pennsylvania were shaped in no small degree by the influence of the Schools of Paris. Indeed, this was then true of almost all American medical teaching, and ambitious American medical students still looked with enthusiasm towards the lecture-rooms and hospitals of the French capital as affording the richest opportunities for the completion of their medical education. Accordingly Otis spent in Paris the first winter after he graduated in Philadelphia. He sailed from New York on the 16th of August, and reached Paris in the latter part of September, 1851.

During his stay in Paris, Otis made diligent use of the opportunities afforded for professional improvement. A manuscript note-book left among his papers shows that he devoted much time to the clinical teachings of the great French masters of that day. He listened to the instructions of Louis, Piorry, Cruveilhier, and Andral. It was at the time his expectation to give especial attention

to the subject of ophthalmic surgery, and accordingly he attended with great diligence the clinics and didactic lectures of Desmarres, but he found the attractions of general operative surgery too strong to permit exclusive attention to this chosen branch, and he continually watched the operations, and listened to the lessons of such surgeons as Nélaton, Civiale, Malgaigne, Jobert (de Lamballe), Roux, and Velpeau. Moreover, the popular excitement which preceded the coup d'état of December 2, 1851, and the probability of bloodshed, directed his attention to the subject of military surgery. Already, November 4th, his note-book records a morning spent at the library of l'Ecole de Médecine in the study of Baron Larrey's "Mémoire," with which he was so well pleased that he at once purchased a copy for closer study. After the coup d'état a considerable number of those wounded at the barricades were carried to the hospitals for treatment, and Otis was thus enabled to take his first practical lessons in military surgery from Velpeau, Roux, and Jobert (de Lamballe).

Meanwhile, however, his diligence in medical studies did not prevent him from spending many pleasant hours in the art galleries and museums, where he found much to gratify his æsthetic nature. Moreover, he took a deep interest in the stirring panorama of French politics, as is shown by a series of letters he took time to write to the *Boston Evening Transcript*.

In the spring of 1852 Otis returned to the United States, reaching New York in the latter part of March. Immediately after his return he established himself at Richmond, Virginia, where he opened an office for general medical and surgical practice, and where his tastes and ambition soon led him to embark in his earliest enterprise in the domain of medical literature. In April, 1853, he issued the first number of *The Virginia Medical and Surgical Journal*. Dr. Howell L. Thomas, of Richmond, was associated with him as co-editor, but the financial risk was assumed entirely by Otis. The journal appeared monthly, each number containing over eighty pages octavo, the whole forming two annual volumes, commencing respectively with the numbers of April and October. It was handsomely printed, and contained from time to time a fair share of original articles, chiefly by physicians residing in Richmond and other parts of Virginia; but its most striking characteristic was the number of translations and abstracts from current French medical literature which appeared in its pages. Dr. Thomas, like

his colleague, was a good French scholar, and had studied in Paris; both took part in the labor of translation and condensation, and as most of the articles were unsigned, it is not always possible to ascribe particular ones to the proper editor.

Notwithstanding its merits several causes contributed to interfere with the financial success of the journal. On the one hand, it was unsupported by the influence and business connections of an established publishing house, or of the faculty of any medical college. On the other hand, the success it might perhaps otherwise have achieved as a local organ of the medical profession in Virginia was impaired by the existence of an already-established rival, *The Stethoscope*, a monthly medical journal edited by Dr. P. Claiborne Gooch, at that time Secretary of the Medical Society of Virginia.

The field of local patronage was not large enough to support two such journals, and both suffered from the competition. Before the close of 1853, Otis found it necessary to secure an associate who could share in the pecuniary support of his enterprise. Thomas retired from the editorship, and was succeeded after the issue of the December number, by Dr. James B. McCaw, of Richmond, who became also part owner of the journal. *The Stethoscope* appears to have suffered still more, for about the same time its editor entered into negotiations with the Virginia Medical Society, as a result of which he sold the journal, and the number of *The Stethoscope* for January, 1854, appeared as "the property and organ of the Medical Society of Virginia, edited by a committee of the society."

This arrangement was, undoubtedly, for a time very prejudicial to the prosperity of the *Virginia Medical and Surgical Journal*, but its editors bravely maintained the struggle, and in the heated discussion concerning the purchase of *The Stethoscope*, that took place during the meeting of the Medical Society of Virginia in April, 1854, Otis, with characteristic gallantry, refused to surrender his independence to secure the passage of resolutions complimentary of the management of his journal.

Otis had, by this time, become dissatisfied with his prospects of professional success in Richmond, and circumstances led him to select Springfield, Massachusetts, as his place of residence. He removed to that town during the summer of 1854. This necessitated changes in the management of the *Virginia Medical and Surgical Journal*. In May, 1854, Dr. J. F. Peebles, of Petersburg, Virginia, became associated with McCaw as one of its editors, while Otis

retired from active participation in its direction, retaining, however, literary connection with it as corresponding editor.

Meanwhile, a single year proved sufficient to disgust the Virginia Medical Society with the task of editing a journal. Its management was found fruitful of unfortunate dissensions, and in May, 1855, the society wisely concluded to sell out. Under new auspices *The Stethoscope* continued to appear monthly until the close of the year, when an arrangement was effected by which it was united with *The Virginia Medical and Surgical Journal*, under the title of *Virginia Medical Journal*, with McCaw as editor, and Otis as corresponding editor.

Although his residence in Richmond had failed to secure for Otis a lucrative practice, this could not well have been expected at his early age. It had, however, given him some opportunities for acquiring experience at the bedside as well as in literature, and if he did not secure the profitable favor of the laity, he at least won for himself the respect and confidence of his professional brethren. He was an active member of the Virginia Medical Society, and represented that body in the American Medical Association at the Richmond meeting of May, 1852. He was also a member of the Richmond Medico-Chirurgical Society, which he represented in the American Medical Association at the New York meeting of May, 1853.

Established at Springfield, Massachusetts, Otis occupied himself more exclusively than heretofore with the duties of private practice, and with better pecuniary success than he had enjoyed at Richmond. He continued for a time to contribute translations, abstracts, and various items to the *Virginia Medical Journal*; but as the demands of his business became more urgent these became fewer, although he continued to be nominally corresponding editor of that journal until the close of 1859. As time wore on, he began to obtain considerable local reputation as a skillful surgeon, and would probably have acquired both wealth and distinction in civil surgical practice but for the outbreak of the War of the Rebellion. This changed the whole tenor of his life. So soon as it became clear to his mind that the struggle was likely to be a prolonged one, he resolved to devote himself to the service of his country. He received from Governor Andrew the appointment of Surgeon to the 27th Regiment of Massachusetts Volunteers, of which Horace C. Lee was Colonel, and was mustered into the service of the United States, September 14, 1861.

The 27th Regiment was raised in the western part of the State of Massachusetts, and was mustered into the service of the United States at Springfield. It left the State November 2, 1861, and proceeded by rail to the vicinity of Annapolis, Maryland, where it went into camp. Here it remained until January 6, 1862, when it was embarked on transports, and accompanied the North Carolina Expedition under General Burnside. It took part in the affair on Roanoke Island, February 8th; landed near Newburn, North Carolina, March 13th, and met with considerable losses during the battle of Newburn on the following day. The regiment remained in North Carolina until October 16, 1863, when it embarked for Fortress Monroe, Virginia, and after a short encampment at Newport News, proceeded to Norfolk, Virginia, where it remained through the following winter.

During almost the whole of this time Surgeon Otis accompanied his regiment and shared its fortunes; sometimes, indeed, performing other duties in addition to his regimental ones, as during the summer and fall of 1862, when he acted as Medical Purveyor to the Department of North Carolina. The exceptional periods were a few days in September, 1862, when he went as medical officer in charge of the steamer "Star of the South" with sick from Newburn to New York, and a few months in the early part of 1863, when he served on detached duty in the Department of the South. While in the Department of the South he attracted the attention of Surgeon Charles H. Crane, U. S. Army, then Medical Director of the Department (afterwards Assistant Surgeon-General of the Army), on whose recommendation he was placed, March 28th, by command of General Hunter, in charge of the hospital steamer "Cosmopolitan," then at Hilton Head, South Carolina, and directed the operations of that vessel in the transportation of the sick and wounded within the limits of the department until May 10, when he was ordered to carry a number of sick and wounded to New York harbor, and after landing them, to turn over the vessel to Surgeon Wm. Ingalls, of the 5th Massachusetts regiment. This order was promptly executed, the vessel was turned over as directed, May 13th, and Otis received a leave of absence for twenty days, at the expiration of which he returned to his regiment.

January 22, 1864, he was again detached and ordered to Yorktown, Virginia, to assume the duties of surgeon-in-chief of General Wistar's command. This responsible position he filled in a satis-

factory manner from the first of February, when he reported for duty at Yorktown, until April 11, when he was relieved and assigned as surgeon-in-chief to General Heckman's division of the 18th Army Corps, then encamped near Portsmouth, Virginia. May 10th he received a sick leave for fifteen days, which, as his health was not restored at its expiration, was extended for thirty days more. June 26, 1864, he tendered his resignation as surgeon of the 27th Massachusetts regiment, and received an appointment as Assistant Surgeon of United States Volunteers, to date from June 30, 1864.

At this time business connected with his resignation and re-appointment brought Otis to Washington, where he renewed his acquaintance with Surgeon Crane, then on duty in the Surgeon General's Office. Surgeon Crane, while Medical Director of the Department of the South, had been most favorably impressed with the culture and ability of the Massachusetts surgeon, and now so effectually commended him to the Acting Surgeon General as to induce that officer to ask his detail for duty in his office. An order to that effect was issued by the Secretary of War July 22, 1864, and Otis was immediately assigned as an assistant to Surgeon John H. Brinton, U. S. Volunteers, at that time Curator of the Army Medical Museum, and engaged in the duty of collecting materials for the Surgical History of the War of the Rebellion. August 30, 1864, Otis was promoted to the rank of Surgeon of Volunteers, and October 3, 1864, was ordered to relieve Surgeon Brinton of his various duties.

From the first, Otis devoted himself with signal zeal and ability to the large and important duties of his new position. Immediately after he took charge of the Surgical Division he inaugurated a system of record books, which proved ultimately of great service in securing the accurate and complete record of individual cases for use in the Surgical History. The rapidly increasing surgical collection of the Army Medical Museum also received great attention from him, and he expended much time in its supervision and study.

Immediately after the close of the war, the Surgeon General of the Army became desirous of securing, by appropriate legislation, the funds necessary to complete and publish the Medical and Surgical History of the War. Accordingly he called upon Otis, and his colleague, Woodward, who had charge of the collection of materials for the Medical History and of the medical branches of the

Museum, to make reports on the extent and nature of the materials collected for the purpose in question. These reports were published by the Surgeon General November 1, 1865, as "Circular No. 6," for the year 1865. This circular was widely distributed, attracted great attention at the time, and satisfactorily attained the object which led to its publication. It formed a quarto volume of 166 pages, with a number of illustrations intended to indicate the character of those regarded as desirable for the Medical and Surgical History. The first half of the volume was occupied by the Surgical Report prepared by Otis. It was a thoughtfully prepared document, which excited the universal admiration of military surgeons in Europe as well as in America.

It became necessary after the close of the war to retain many of the staff surgeons of volunteers in the service for duty in the general hospitals or other purposes after the great armies had been disbanded, and Otis was, of course, retained with that rank as long as possible; but it was foreseen that the great work he had commenced would occupy a number of years, and he was induced to make arrangements for entering the army as an assistant surgeon. Accordingly he passed the examination prescribed by law, and February 28, 1866, received an appointment as Assistant Surgeon, U. S. Army, but he was not finally mustered out of service as surgeon of volunteers until June 4, 1866, and hence did not accept his commission as Assistant Surgeon U. S. A., until the 6th of that month.

Meanwhile Otis was devoting himself to the study and arrangement of the materials collected for the Surgical History with indefatigable energy, and while engaged upon that work received authority to publish two preliminary studies on special subjects connected therewith, which greatly increased the reputation he had won by his report in Circular No. 6. The first was *A Report on Amputation at the Hip-joint in Military Surgery*, published as Circular No. 7, Surgeon General's Office, July 1, 1867. In this he not merely presented and analyzed the histories of the several amputations at this joint reported to the Surgeon General's Office during the civil war, but discussed with the critical abilities of a master the whole literature of the subject so far as it was at the time accessible to him. An examination of this monograph shows that he had already pretty well begun to emancipate himself from the leading-strings of the French school, and had fully acquired the desire, so

manifest in his subsequent work, to compare and weigh all accessible human knowledge on each branch of his subject before arriving at his own conclusions.

These characteristics were, if possible, still more fully displayed in the second of the studies referred to: *A Report on Excisions of the Head of the Femur for Gunshot Injury*, published as Circular No. 2, Surgeon General's Office, January 2, 1869; a monograph in which the subject was treated in a manner similar to that of Circular No. 7, but with a still greater wealth of literary resources. The appearance of each of these monographs was welcomed with acclamations of praise, in which the authoritative expressions of approval by the recognized masters of European surgery were united with the encomiums of the American military surgeons.

Great interest in the forthcoming Surgical History of the War was excited by these publications, and very high expectations were formed, which, however, were fully realized by the character of the *First Surgical Volume*. This volume was issued in 1870. It treated of the special wounds and injuries of the head, face, neck, spine, and chest, was richly illustrated, and discussed the vast amount of material collected during the civil war, in connection with the several subjects treated, with characteristic learning and ability. The *Second Surgical Volume* was issued in 1876. It treated of the wounds and injuries of the abdomen, pelvis, back, and upper extremities. Fully equal in interest and execution to the first volume, it was much more voluminous. The two volumes represent a prodigious amount of patient labor on the part of the editor. The extremely favorable manner in which they were received in surgical circles at home and abroad is well known.

During the interval between the appearance of these two volumes, and subsequently, Otis found time to prepare and publish several valuable reports on subjects connected with military surgery, of which the most important were: *A Report of Surgical Cases treated in the Army of the United States from 1865 to 1871*, issued as Circular No. 3 from the Surgeon General's Office, August 17, 1871, *A Report on a Plan for Transporting Wounded Soldiers by Railway in time of War*, Surgeon General's Office, 1875; and *A Report on the Transport of Sick and Wounded by Pack Animals*, issued as Circular No. 9 from the Surgeon General's Office in 1877. A full list of his official and other publications would occupy too much space to be presented in this place.

In the midst of this successful but laborious career, during the month of May, 1877, his health, never very robust, gave way, and, although he survived for several years, he was a constant invalid, to whom death came in the end as a welcome release from suffering. He was engaged at the time of his death on the third surgical volume, which he has left in an unfinished condition; a colossal fragment that must require great labor to complete in a manner worthy of the first two volumes.

Otis received the appointments of captain, major, and lieutenant-colonel by brevet, to date from September 29, 1866, "for faithful and meritorious services during the war." He was promoted to be surgeon in the army, with the rank of major, March 17, 1880. He was elected a foreign member of the Medical Society of Norway, October 26, 1870; a foreign corresponding member of the Surgical Society of Paris, August 11, 1875; and an honorary life member of the Massachusetts Medical Society in February, 1877. He was also at the time of his death a member of the Philosophical Society of Washington, and of the Academy of Natural Sciences of Philadelphia.

In expressing his high appreciation of the character and value of the surgical works of his late colleague, the writer of these pages does but echo the universal language of competent critics throughout the civilized world. On all sides the opinion has been expressed that they have not only made the name of Otis illustrious, but have reflected the greatest credit upon the intelligent liberality of the Government of the United States, and upon the Medical Corps of the Army.

During his connection with the Museum, Otis always took deep interest in the anatomical collection, now embracing about two thousand human crania. As early as January, 1873, the Surgeon General at his instance made a fruitless endeavor to procure an appropriation for the publication of an illustrated catalogue of this valuable collection. To facilitate this object Otis prepared a checklist of the specimens, which was printed in 1876, but the pecuniary means for preparing and publishing the larger work have not yet been provided.

Until his last illness Otis retained much of the fondness for polite literature which characterized him in early life. He had, moreover, considerable taste for music and the fine arts. These qualities made his companionship charming to those who enjoyed his intimacy.

Hesitating, often embarrassed, in his manner in ordinary conversation, especially with strangers, he became eloquent when warmed by the discussion of any topic in which he took interest, and he took interest in a great variety of subjects besides those directly connected with the work of his life.

Many warm personal friends share the grief of his family at his untimely death, which, as has been well said by the Surgeon-General, "will be deeply deplored not only by the Medical Corps of the Army, but by the whole medical profession at home and abroad."

LIST OF THE PUBLICATIONS OF G. A. OTIS, M.D., Etc.

Case of Pericarditis in a child of four years and seven months of age. [Reported to the Medico-Chirurgical Society of Richmond, March 1, 1853.] The Virginia Medical and Surgical Journal, Vol. I, 1853, p. 33.

On Hemorrhage from the Umbilicus in new-born Infants. Same Journal, Vol. II, 1853, p. 49.

A Report of a Case in which an Enlargement of the Isthmus of the Thyroid Body was successfully extirpated. Same Vol., p. 115.

On the Per-chloride of Iron in the Treatment of Aneurisms. [Remarks appended to a translation of an article by Malgaigne: "De l'emploi du perchlorure de fer dans le Traitement des Anéurismes." L'Abeille Médicale, Octobre, 1853, p. 292 *et seq.*] Same Vol., pp. 295 and 497.

On the Local Treatment of Erysipelas. [Abstract of remarks made in the Medico-Chirurgical Society of Richmond, January 17, 1854.] Same Journal, Vol. III, 1854, p. 13.

Translation, with Notes, of Velpeau's Review of the Surgical Clinique of La Charité, during the Scholastic Year of 1853-4. [Translated from Le Moniteur des Hopitaux, 1854, p. 801 *et seq.*] Same Journal, Vol. IV, 1855, pp. 31, 111, and 321, and Vol. V, 1855, pp. 213, 298, and 378.

Remarks and Excerpts relating to Variola and Vaccinia. Virginia Medical Journal, Vol. VII, 1856, p. 109.

On Strangulated Hernia in Children. Same Journal, Vol. X, 1858, p. 201.

Letter to the Surgeon General of Massachusetts on the Sanitary Condition of the 27th Mass. Vols., from Camp Reed, near Springfield, Mass., October 5, 1861. The Boston Medical and Surgical Journal, Vol. 65, 1862, p. 204.

Letter to the same, on the same, from Camp Springfield, near Annapolis, Md. Same Vol., p. 435.

Letter to the same, from Newbern, N. C., March 28, 1862, [giving an account of the participation of the regiment in the battle of Newbern, and of his management of the wounded.] Same Journal, Vol. 66, 1862, p. 237.

The Surgical portion of (pp. 1-88) *Circular No. 6, War Department, Surgeon General's Office, November 1, 1865.* Reports on the extent and nature of the materials available for the preparation of a Medical and Surgical History of the Rebellion. Printed for the Surgeon General's Office by J. B. Lippincott & Co., Philadelphia, 1865, 4to., pp. 88.

Circular No. 7, War Department, Surgeon General's Office, Washington, July 1, 1867. A Report on Amputations at the Hip-joint in Military Surgery. 4to., pp. 87.

Observations on some Recent Contributions to the Statistics of Excisions and Amputations at the Hip for Injury. The American Journal of the Medical Sciences, Vol. LVI, July, 1868, p. 128.

Rejoinder to a Reply to a Review of Dr. Eve's Contribution on the History of Hip-joint Operation. The Buffalo Medical and Surgical Journal, Vol. VIII, August, 1868, p. 21.

Circular No. 2, War Department, Surgeon General's Office, Washington, January 2, 1869. A Report on Excision of the Head of the Femur for Gun-shot Injury. 4to., pp. 141.

Medical and Surgical History of the War of the Rebellion, 1861-1865, Part 1, Vol. II, being the First Surgical Volume. Washington, Government Printing Office, 1870, 4to., pp. 650. Second issue, 1875.

Circular No. 3, War Department, Surgeon General's Office, Washington, August 17, 1871. A Report of Surgical Cases treated in the Army of the United States from 1865 to 1871. 4to., pp. 196.

Memorandum of a Case of Re-amputation at the Hip, with Remarks on the Operation. The American Journal of the Medical Sciences, Vol. LXI, January, 1871, p. 141.

A Report on the Plan for Transporting Wounded Soldiers by Railway in time of War. Washington, Surgeon General's Office, 1875, 8vo., pp. 56.

Description of Selected Specimens from the Surgical Section of the Army Medical Museum at Washington. [International Exhibition of 1876.] Gibson Bros., Washington, 1876, 8vo., pp. 22.

Description of the U. S. Army Medicine Transport Cart, Model of 1876, prepared in conjunction with Brevet Lieutenant Colonel D. L. Huntington, Assistant Surgeon U. S. A. [International Exhibition of 1876.] Gibson Bros., Washington, 1876, 8vo., pp. 16.

Check-List of Preparations and Objects in the Section of Human Anatomy of the U. S. Army Medical Museum. [International Exhibition of 1876.] Gibson Bros., Washington, 1876, pp. 135. Second edition, Gibson Bros., Washington, 1880, 8vo., pp. 194.

Medical and Surgical History of the War of the Rebellion, 1861-1865, Part II, being the Second Surgical Volume. Washington, Government Printing Office, 1876, 4to., pp. 1024. Second issue, 1877.

Circular No. 9, War Department, Surgeon General's Office, March 1, 1877. A Report to the Surgeon General on the Transport of Sick and Wounded by Pack Animals. 4to., pp. 32.

Report of a Board of Officers to decide on a Pattern of Ambulance Wagon for Army Use. [Prepared by him as recorder of the board.] Washington, Government Printing Office, 1878, 8vo., pp. 79.

Contributions from the Army Medical Museum. Boston Medical and Surgical Journal, Vol. XCVI, March, 1877, p. 361.

Article *Surgery* in Johnson's New Universal Cyclopædia. New York, A. J. Johnson & Son, 1878, Vol. IV, pp. 1678-1686.

Notes on Contributions to the Army Medical Museum by Civil Practitioners. Boston Medical and Surgical Journal, Vol. XCVIII, February, 1878, p. 163.

Recent Progress in Military Surgery. Same Vol., April, p. 531.

Photographs of Surgical Cases and Specimens, taken at the Army Medical Museum, with Histories of three hundred and seventy-five cases. Washington, Surgeon General's Office, 1866. 1881, 8 vols., 4to.

The next communication was by Mr. ALEXANDER GRAHAM BELL

UPON A MODIFICATION OF WHEATSTONE'S MICROPHONE AND ITS APPLICABILITY TO RADIOPHONIC RESEARCHES.

In August, 1880, I directed attention to the fact that thin disks or diaphragms of various materials become sonorous when exposed to the action of an intermittent beam of sunlight, and I stated my belief that the sounds were due to molecular disturbances produced in the substance composing the diaphragm.* Shortly afterwards Lord Raleigh undertook a mathematical investigation of the subject, and came to the conclusion that the audible effects were caused by the bending of the plates under unequal heating.† This explanation has recently been called in question by Mr. Preece,‡ who has

* Amr. Ass. for Advancement of Science, Aug. 27, 1881.

† Nature, Vol. XXIII, p. 274.

‡ Roy. Soc., Mar. 10, 1881.

expressed the opinion that although vibrations may be produced in the disks by the action of the intermittent beam, such vibrations are not the cause of the sonorous effects observed. According to him the ærial disturbances that produce the sound arise spontaneously in the air itself by sudden expansion due to heat communicated from the diaphragm; every increase of heat giving rise to a fresh pulse of air. Mr. Preece was led to discard the theoretical explanation of Lord Raleigh on account of the failure of experiments undertaken to test the theory.

He was thus forced, by the supposed insufficiency of the explanation, to seek in some other direction the cause of the phenomenon observed, and, as a consequence, he adopted the ingenious hypothesis alluded to above. But the experiments which had proved unsuccessful in the hands of Mr. Preece were perfectly successful when repeated in America under better conditions of experiment, and the supposed necessity for another hypothesis at once vanished. I have shown in a recent paper read before the National Academy of Science,* that audible sounds result from the expansion and contraction of the material exposed to the beam, and that a real to and fro vibration of the diaphragm occurs capable of producing sonorous effects. It has occurred to me that Mr. Preece's failure to detect with a delicate microphone the sonorous vibrations that were so easily observed in our experiments, might be explained upon the supposition that he had employed the ordinary form of Hughes' microphone shown in Fig. 1, and that the vibrating area was confined to the central portion of the disk. Under such circumstances it might easily happen that both the portions (A B) of the microphone might touch portions of the diaphragm which were practically at rest. It would, of course, be interesting to ascertain whether any such localization of the vibration as that supposed really occurred, and I have great pleasure in showing to you to-night the apparatus by means of which this point has been investigated. [See Fig. 2.]

The instrument is a modification of the form of microphone devised in 1827 by the late Sir Charles Wheatstone, and it consists essentially of a stiff wire, (A,) one end of which is rigidly attached to the centre of a metallic diaphragm (B.) In Wheatstone's original arrangement, the diaphragm was placed directly against the ear

* April 21, 1881.

Fig 1.

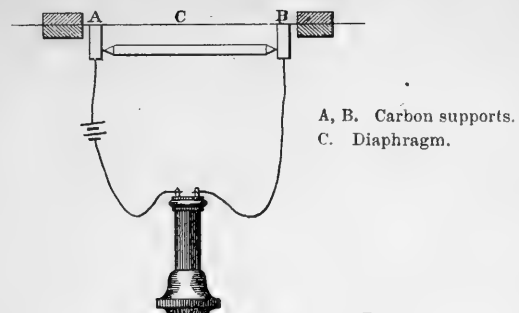
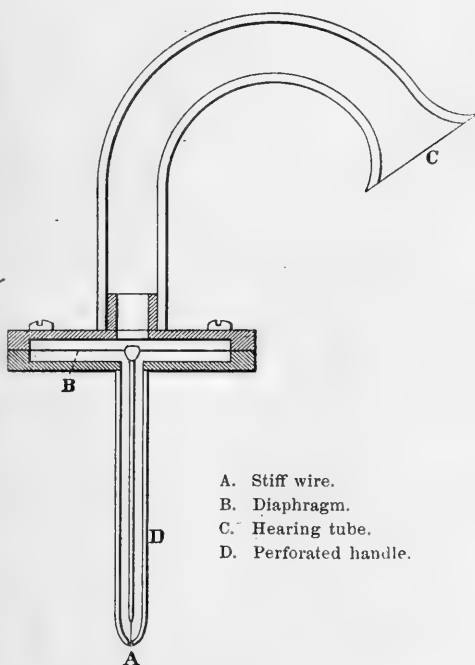
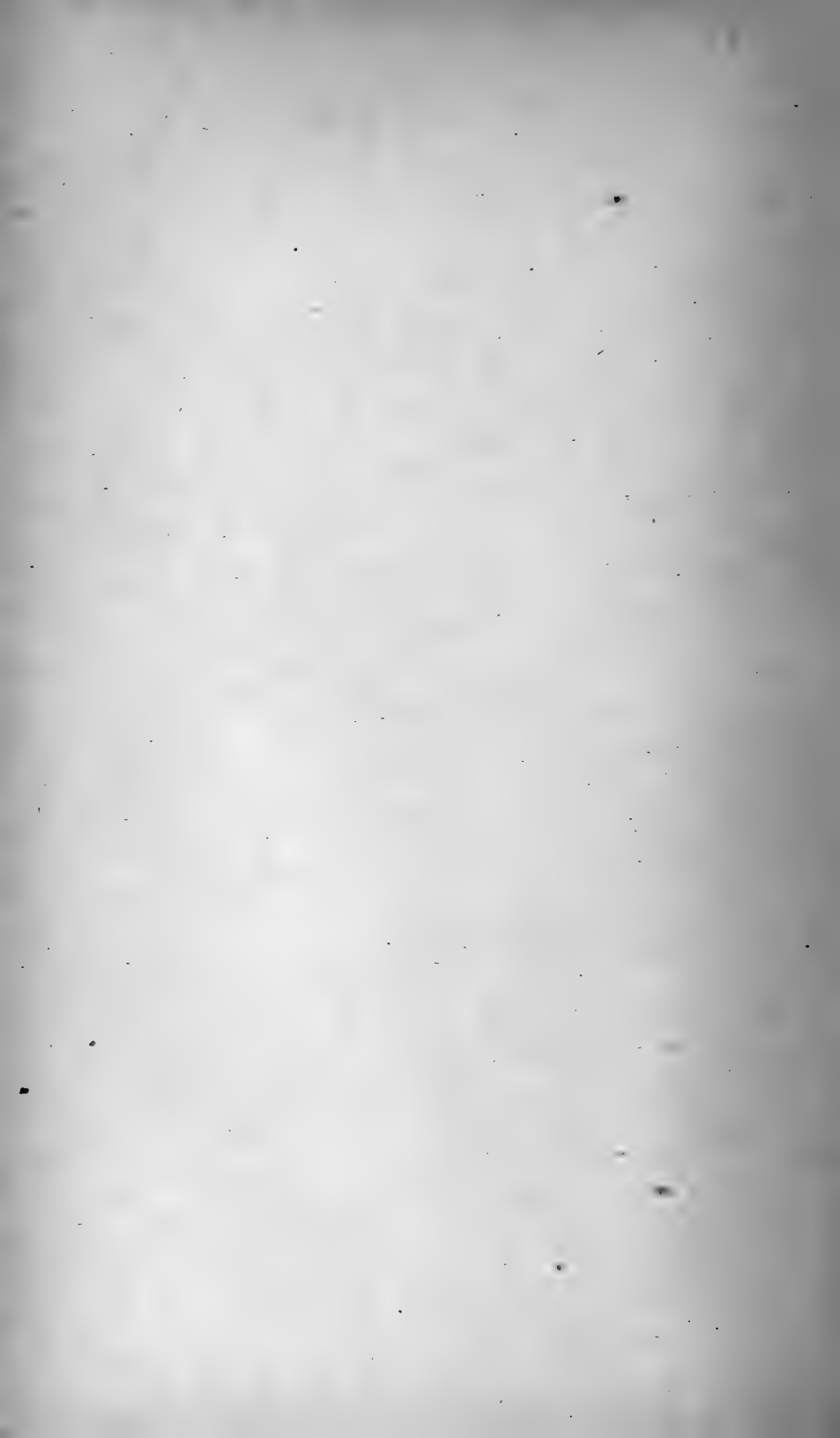


Fig 2.





and the free extremity of the wire was rested against some sounding body, like a watch. In the present arrangement the diaphragm is clamped at the circumference like a telephone-diaphragm, and the sounds are conveyed to the ear through a rubber hearing-tube (C.) The wire passes through the perforated handle (D,) and is exposed only at the extremity. When the point (A) was rested against the centre of a diaphragm, upon which was focussed an intermittent beam of sunlight, a clear musical tone was perceived by applying the ear to the hearing-tube (C.) The surface of the diaphragm was then explored with the point of the microphone, and sounds were obtained in all parts of the illuminated area, and in the corresponding area on the other side of the diaphragm. Outside of this area on both sides of the diaphragm the sounds became weaker and weaker until at a certain distance from the centre they could no longer be perceived.

At the points where one would naturally place the supports of a Hughes' microphone [see Fig. 1,] no sound was observed. We were also unable to detect any audible effects when the point of the microphone was rested against the support to which the diaphragm was attached. The negative results obtained in Europe by Mr. Preece may, therefore, be reconciled with the positive results obtained in America by Mr. Tainter and myself. A still more curious demonstration of localization of vibration occurred in the case of a large metallic mass. An intermittent beam of sunlight was focused upon a brass weight (1 kilogram,) and the surface of the weight was then explored with the microphone shown in Fig. 2. A feeble but distinct sound was heard upon touching the surface within the illuminated area, and for a short distance outside, but not in other parts.

In this experiment, as in the case of the thin diaphragm, absolute contact between the point of the microphone, and the surface explored was necessary in order to obtain audible effects. Now, I do not mean to deny that sound waves may be originated in the manner suggested by Mr. Preece, but I think that our experiments have demonstrated that the kind of action described by Lord Raleigh actually occurs and that it is sufficient to account for the audible effects observed.

The next communication was by Mr. J. M. TONER on

EARTH VIBRATIONS AT NIAGARA FALLS.

In June, 1874, the speaker, in company with Dr. J. D. Jackson, of Kentucky, visited the Clifton House on the Canada side of Niagara. On the night of his arrival he was kept awake by the illness of his companion, and his attention was drawn to the frequent rattling of the doors and windows of his room. He was first led to suppose, while speculating upon the cause, that the vibration might be due to pulsations in the air produced by the falling water; but upon further reflection concluded that it could not be satisfactorily explained in that way, as it continued independently of the direction of the wind. On the following day he made it the subject of conversation with others, but no one seemed to agree with him. He had occasion, however, to note when his chair was tilted back against the stone wall of the house that a tremulous motion, or grating was perceptible. At the time this tremor was a novelty to him, but subsequently he had met with allusions to it by several writers. He was led to the following explanation, viz: that the fall of such a large body of water through so great a vertical distance, must necessarily impart vibrations to the massive rocks which form the trough of the river above and below the falls, and that these vibrations are transmitted through the earth itself. To test this theory, he made on the next day the following experiments: A large carving dish holding water was placed on the rock between the falls and the hotel. Upon the water was poured some sweet oil, and it was seen that wave-rings appeared on the surface of the water. These rings were made more distinct by placing a mirror so as to view them by reflection. No rhythm was detected in these vibrations. The dish was placed in many localities, more than thirty in number, and at varying distances from the falls. Waves were observed in it from the Burning Spring above the falls, and as far as half a mile below the small suspension bridge. They were also noted on the steps of the little Episcopal Church, a mile west of the Hotel on the Canada side. Similar results were obtained on the American side.

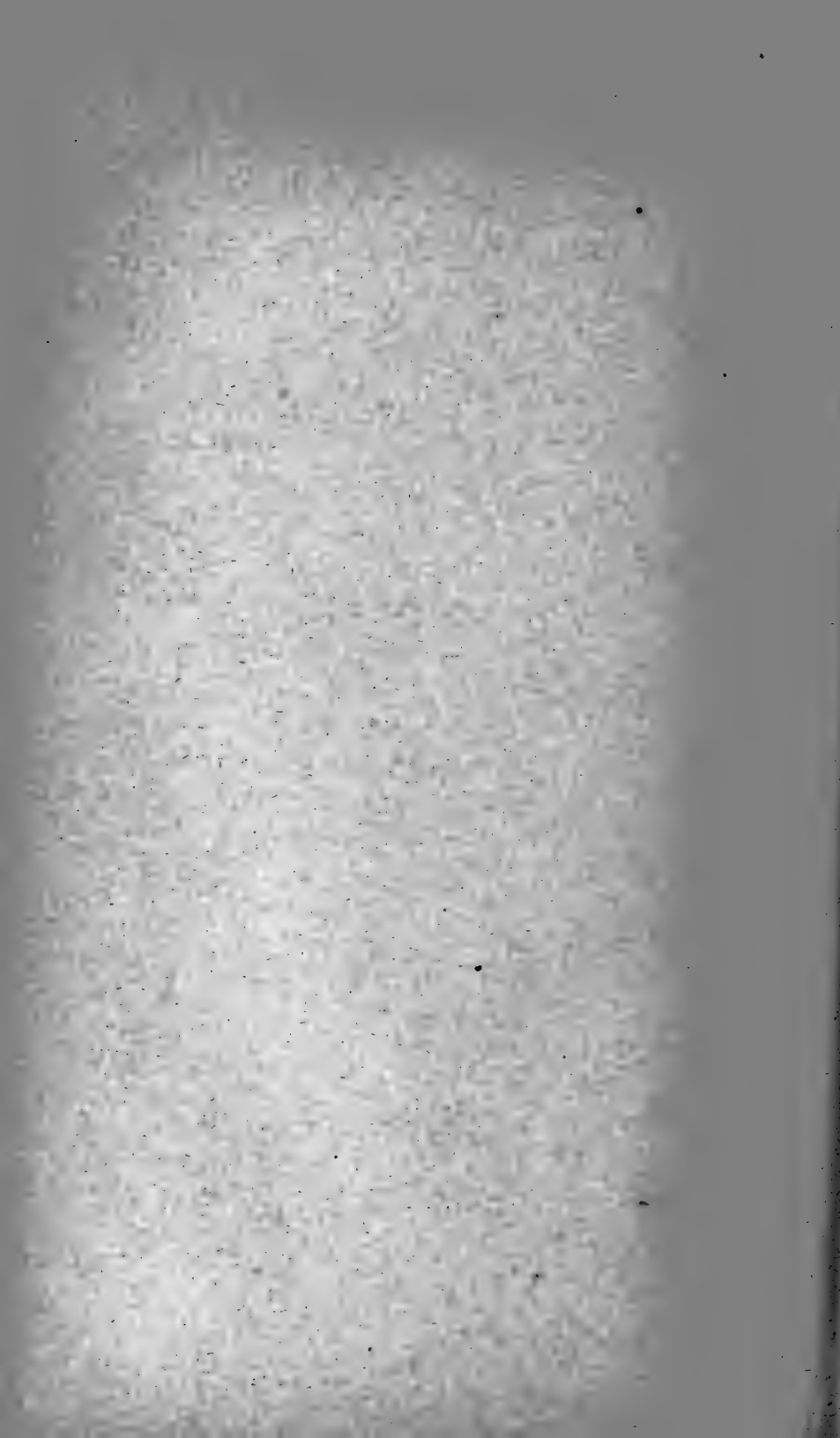
At the conclusion of Mr. Toner's remarks the Society adjourned to October 8th.

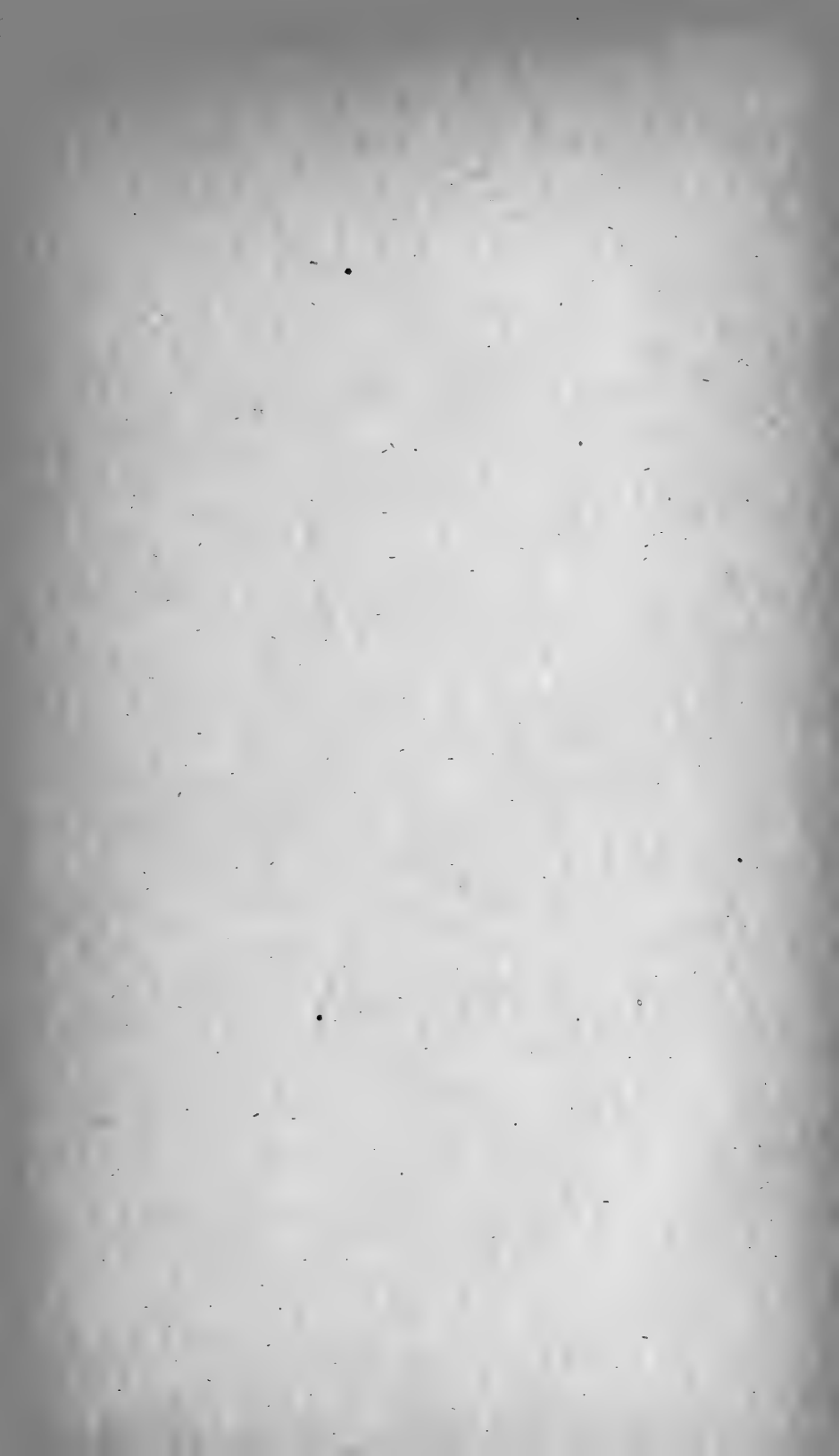
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BULLETIN
OF THE
PHILOSOPHICAL SOCIETY
OF
WASHINGTON.

VOL. V.

Containing the Minutes of the Society from the 203d Meeting,
October 8, 1881, to the 226th Meeting, Dec. 16, 1882.

PUBLISHED BY THE CO-OPERATION OF THE SMITHSONIAN INSTITUTION.

WASHINGTON:
1883.

JUDD & DETWEILER, PRINTERS,
WASHINGTON, D. C.

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CONSTITUTION, STANDING RULES,

AND

LIST OF OFFICERS AND MEMBERS

OF

THE PHILOSOPHICAL SOCIETY

OF

WASHINGTON.

CONSTITUTION

OF

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

ARTICLE I. The name of this Society shall be THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

ARTICLE II. The officers of the Society shall be a President, four Vice-Presidents, a Treasurer, and two Secretaries.

ARTICLE III. There shall be a General Committee, consisting of the officers of the Society and nine other members.

ARTICLE IV. The officers of the Society and the other members of the General Committee shall be elected annually by ballot; they shall hold office until their successors are elected, and shall have power to fill vacancies.

ARTICLE V. It shall be the duty of the General Committee to make rules for the government of the Society, and to transact all its business.

ARTICLE VI. This constitution shall not be amended except by a three-fourths vote of those present at an annual meeting for the election of officers, and after notice of the proposed change shall have been given in writing at a stated meeting of the Society at least four weeks previously.

STANDING RULES

FOR THE GOVERNMENT OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON.

JANUARY, 1881.

1. The Stated Meetings of the Society shall be held at 8 o'clock P. M. on every alternate Saturday ; the place of meeting to be designated by the General Committee.

2. Notice of the time and place of meeting shall be sent to each member by one of the Secretaries.

When necessary, Special Meetings may be called by the President.

3. The Annual Meeting for the election of officers shall be the last stated meeting in the month of December.

The order of proceedings (which shall be announced by the Chair) shall be as follows :

First, the reading of the minutes of the last Annual Meeting.

Second, the presentation of the annual reports of the Secretaries, including the announcement of the names of members elected since the last annual meeting.

Third, the presentation of the annual report of the Treasurer.

Fourth, the announcement of the names of members who having complied with Section 12 of the Standing Rules, are entitled to vote on the election of officers.

Fifth, the election of President.

Sixth, the election of four Vice-Presidents.

Seventh, the election of Treasurer.

Eighth, the election of two Secretaries.

Ninth, the election of nine members of the General Committee.

Tenth, the consideration of Amendments to the Constitution of

the Society, if any such shall have been proposed in accordance with Article VI of the Constitution.

Eleventh, the reading of the rough minutes of the meeting.

4. Elections of officers are to be held as follows:

In each case nominations shall be made by means of an informal ballot, the result of which shall be announced by the Secretary; after which the first formal ballot shall be taken.

In the ballot for Vice-Presidents, Secretaries, and Members of the General Committee, each voter shall write on one ballot as many names as there are officers to be elected, viz., four on the first ballot for Vice-Presidents, two on the first for Secretaries, and nine on the first for Members of the General Committee; and on each subsequent ballot as many names as there are persons yet to be elected; and those persons who receive a majority of the votes cast shall be declared elected.

If in any case the informal ballot result in giving a majority for any one, it may be declared formal by a majority vote.

5. The Stated Meetings, with the exception of the annual meeting, shall be devoted to the consideration and discussion of scientific subjects.

The Stated Meeting next preceding the Annual Meeting shall be set apart for the delivery of the President's Annual Address.

6. Sections representing special branches of science may be formed by the General Committee upon the written recommendation of twenty members of the Society.

7. Persons interested in science, who are not residents of the District of Columbia, may be present at any meeting of the Society, except the annual meeting, upon invitation of a member.

8. Similar invitations to residents of the District of Columbia, not members of the Society, must be submitted through one of the Secretaries to the General Committee for approval.

9. Invitations to attend during three months the meetings of the Society and participate in the discussion of papers, may, by a vote of nine members of the General Committee, be issued to persons nominated by two members.

10. Communications intended for publication under the auspices of the Society shall be submitted in writing to the General Committee for approval.

11. New members may be proposed in writing by three members of the Society for election by the General Committee: but no person shall be admitted to the privileges of membership unless he signifies his acceptance thereof in writing within two months after notification of his election.

12. Each member shall pay annually to the Treasurer the sum of five dollars, and no member whose dues are unpaid shall vote at the annual meeting for the election of officers, or be entitled to a copy of the Bulletin.

In the absence of the Treasurer, the Secretary is authorized to receive the dues of members.

The names of those two years in arrears shall be dropped from the list of members.

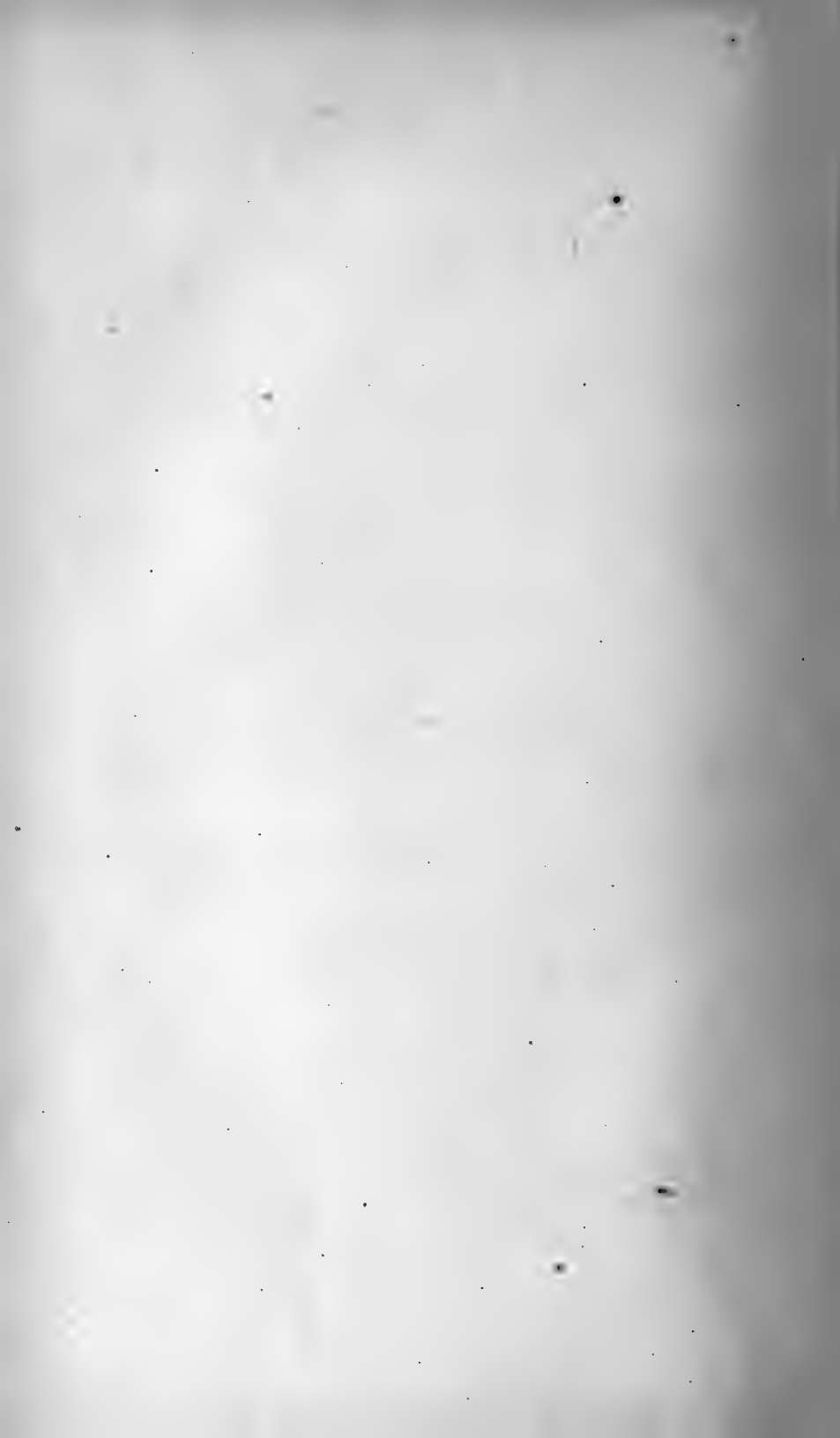
Notice of resignation of membership shall be given in writing to the General Committee through the President or one of the Secretaries.

13. The fiscal year shall terminate with the Annual Meeting.

14. Members who are absent from the District of Columbia for more than twelve months may be excused from payment of the annual assessments, in which case their names shall be dropped from the list of members. They can, however, resume their membership by giving notice to the President of their wish to do so.

15. Any member not in arrears may, by the payment of one hundred dollars at any one time, become a life member, and be relieved from all further annual dues and other assessments.

All moneys received in payment of life membership shall be invested as portions of a permanent fund, which shall be directed solely to the furtherance of such special scientific work as may be ordered by the General Committee.



STANDING RULES

OF THE

GENERAL COMMITTEE OF THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

JANUARY, 1881.

1. The President, Vice-Presidents, and Secretaries of the Society shall hold like offices in the General Committee.

2. The President shall have power to call special meetings of the Committee, and to appoint Sub-Committees.

3. The Sub-Committees shall prepare business for the General Committee, and perform such other duties as may be entrusted to them.

4. There shall be two Standing Sub-Committees; one on Communications for the Stated Meetings of the Society, and another on Publications.

5. The General Committee shall meet at half-past seven o'clock on the evening of each Stated Meeting, and by adjournment at other times.

6. For all purposes except for the amendment of the Standing Rules of the Committee or of the Society, and the election of members, six members of the Committee shall constitute a quorum.

7. The names of proposed new members recommended in conformity with Section 11 of the Standing Rules of the Society, may be presented at any meeting of the General Committee, but shall lie over for at least four weeks before final action, and the concur-

rence of twelve members of the Committee shall be necessary to election.

The Secretary of the General Committee shall keep a chronological register of the elections and acceptances of members.

8. These Standing Rules, and those for the government of the Society, shall be modified only with the consent of a majority of the members of the General Committee.

R U L E S
FOR THE
P U B L I C A T I O N O F T H E B U L L E T I N
O F T H E
P H I L O S O P H I C A L S O C I E T Y O F W A S H I N G T O N .
J A N U A R Y , 1 8 8 1 .

1. The President's annual address shall be published in full.
2. The annual reports of the Secretaries and of the Treasurer shall be published in full.
3. When directed by the General Committee, any communication may be published in full.
4. Abstracts of papers and remarks on the same will be published, when presented to the Secretary by the author in writing within two weeks of the evening of their delivery, and approved by the Committee on Publications. Brief abstracts prepared by one of the Secretaries and approved by the Committee on Publications may also be published.
5. Communications which have been published elsewhere, so as to be generally accessible, will appear in the Bulletin by title only, but with a reference to the place of publication, if made known in season to the Committee on Publications.

N O T E . *The attention of members to the above rules is specially requested.*

ELECTED DECEMBER 17, 1881.

Secretaries -----MARCUS BAKER, T. N. GILL.

J. S. BILLINGS,	WILLIAM HARKNESS,
C. E. DUTTON,	GARRICK MALLERY,
J. R. EASTMAN,	SIMON NEWCOMB,
E. B. ELLIOTT,	J. W. POWELL,
C. A. SCHOTT.	

T. N. GILL, *Chairman*. CLEVELAND ABBE, S. F. BAIRD,* MARCUS BAKER.

* As Secretary of the Smithsonian Institution.

LIST OF MEMBERS

OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON.

Corrected to May, 1882.

- (a) indicates a *founder* of the Society.
 (b) indicates *deceased*.
 (c) indicates *absent* from the District of Columbia and excused from payment of dues until announcing their return.
 (d) indicates *resigned*.
 (e) indicates *dropped* for non-payment or nothing known of him.

NAME.	P. O. ADDRESS AND RESIDENCE.	DATE OF ADMISSION.
Abbe, Cleveland.....	Army Signal Office. 2017 I St. N. W.	1871, Oct. 29
Abert, Sylvanus Thayer.....	Engineer's Office, War Department. 1724 Penn. Ave. N.W.	1875, Jan. 30
Adams, Henry	1605 H St.	1831, Feb. —
Aldis, Asa Owen	1617 Rhode Island Ave. N. W.	1873, Mar. 1
Allen, James	Army Signal Office. 1707 G St. N. W.	1882, Feb. 25
Alvord, Benjamin	1207 Q St. N. W.	1872, Mar. 23
Antisell, Thomas (a)	Patent Office. 1311 Q St. N. W.	1871, Mar. 13
Avery, Robert Stanton.....	Coast and Geodetic Survey Office. 320 A St. S. E.	1879, Oct. 11
Babcock, Orville Elias.....	2024 G St. N. W.	1871, June 9
Bailey, Theodorus (b) .....	.....	1873, Mar. 1
Baird, Spencer Fullerton (a)	Smithsonian Institution. 1445 Mass. Ave. N. W.	1871, Mar. 13
Baker, Frank.....	326 C St. N. W.	1881, May 14
Baker, Marcus.....	Coast and Geodetic Survey Office. 1205 Rhode Island Ave. N. W.	1876, Mar. 11
Bancroft, George.....	1623 H St. N. W.	1875, Jan. 16
Barnes, Joseph K (a)	Surg. Genl's Office. 1723 H St. N. W.	1871, Mar. 13
Bartley, Thomas Welles	Office, 1343 F St. N.W. Res., 1016 13th St. N. W.	1873, Mar. 29
Bates, Henry Hobart.....	Patent Office. 1313 R St. N. W.	1871, Nov. 4
Beardslee, Lester Anthony (c).....	Navy Department. ..	1875, Feb. 27
Bell, Alexander Graham	1221 Conn. Ave. N.W. Res., 1302 Conn. Ave. N. W.	1879, Mar. 29
Bell, Chichester Alexander.....	1221 Conn. Ave. N.W. Res., 2023 Mass. Ave. N. W.	1881, Oct. 8
Benét, Stephen Vincent (a)	Ordnance Office, War Department. 1717 I St. N. W.	1871, Mar. 13
Bessels, Emil.....	Smithsonian Institution. 1441 Mass. Ave. N. W.	1875, Jan. 16
Billings, John Shaw (a)	Surg. Genl's Office. 3027 N St. N. W.	1871, Mar. 13
Birney, William.....	330 4½ St. N.W. Res., 1901 Harewood Ave., Le Droit Park.	1879, Mar. 29
Birnie, Rogers (c).....	Cold Spring, Putnam Co., N. Y.	1876, Mar. 11
Burchard, Horatio Chapin.....	Director of the Mint, Treasury Dept. Res., Riggs House.	1879, May 10
Burnett, Swan Moses.....	1215 I St. N. W.	1879, Mar. 29
Busey, Samuel Clagett.....	1525 I St. N. W.	1874, Jan. 17
Capron, Horace (a)	The Portland.....	1871, Mar. 13
Case, Augustus Ludlow (c).....	Navy Department. Bristol, R. I.	1872, Nov. 16
Casey, Thomas Lincoln (a)	Engineer Bureau, War Department. 1419 K St. N. W.	1871, Mar. 13

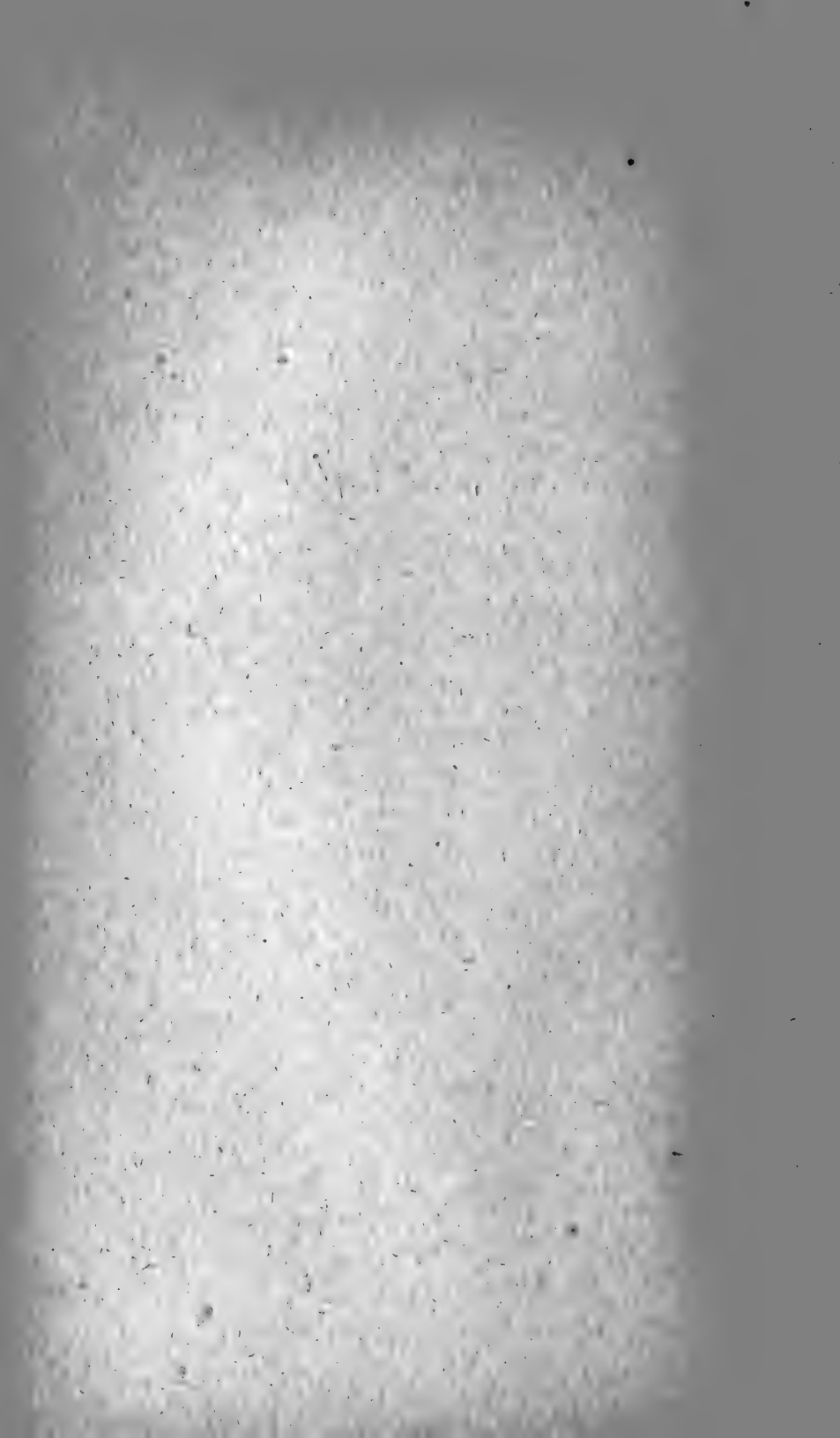
NAME.	P. O. ADDRESS AND RESIDENCE.	DATE OF ADMISSION.
Caziare, Louis Vasmer.....	Army Signal Office. 1446 N St. N. W.	1882, Feb. 25
Chase, Salmon Portland (a b).....	.....	1871, Mar. 13
Chickering, John White, Jr.	Deaf Mute College, Kendall Green.....	1874, Apr. 11
Christie, Alexander Smyth.....	Coast and Geodetic Survey Office. 1102 14th St. N. W.	1880, Dec. 4
Clapp, William Henry.....	Army Signal Office. 806 18th St. N. W.	1882, Feb. 25
Clark, Edward.....	Architect's Office, Capitol. 417 4th St. N. W.	1877, Feb. 24
Clark, Ezra Westcott.....	Revenue Marine Bureau, Treasury Department. Res., Woodley road.	1882, Mar. 25
Clarke, Frank Wigglesworth (c).....	University of Cincinnati. Albion Place, Cincinnati, Ohio.	1874, Apr. 11
Coffin, John Huntington Crane (a).....	1901 I St. N. W.	1871, Mar. 13
Collins, Frederick (b).....	.....	1879, Oct. 21
Comstock, John Henry.....	Cornell University, Ithaca, N. Y.	1880, Feb. 14
Coues, Elliott.....	Smithsonian Inst. 1321 N St. N. W. ...	1874, Jan. 17
Craig, Benjamin Faneuil (a b).....	.....	1871, Mar. 13
Craig, Robert.....	Army Signal Office. 1008 I St. N. W.	1873, Jan. 4
Craig, Thomas.....	Johns Hopkins Univ., Baltimore, Md.	1879, Nov. 22
Crane, Charles Henry (a).....	Surg. Gen'l's Office. 1909 F St. N. W.	1871, Mar. 13
Curtis, Josiah.....	428 7th street N. W. Riggs House.....	1874, Mar. 28
Cutts, Richard Dominicus.....	Coast and Geodetic Survey Office. 1725 H St. N. W.	1871, Apr. 29
Dall, William Healey (a).....	P. O. Box 406. 1119 12th St. N. W.....	1871, Mar. 13
Davis, Charles Henry (b).....	.....	1874, Jan. 17
Davis, Charles Henry.....	Navy Department. 1705 Rhode Island Ave. N. W.	1880, June 19
Dean, Richard Crain (b).....	.....	1872, Apr. 23
De Caidry, William Augustin.....	Commissary General's Office. 924 19th St. N. W.	1881, Apr. 30
De Land, Theodore Louis.....	Treasury Dept. 126 7th St. N. E.	1880, Dec. 18
Dewey, George (d).....	Light House Board. 826 14th St. N. W.	1879, Feb. 15
Doolittle, Myrick Hascall.....	Coast and Geodetic Survey Office. 1925 I St. N. W.	1876, Feb. 12
Dorr, Fredric William (b).....	.....	1874, Jan. 17
Dunwoody, Henry Harrison Chase	Army Signal Office. 1412 G St. N. W.	1873, Dec. 20
Dutton, Clarence Edward.....	Geological Survey.....	1872, Jan. 27
Dyer, Alexander B. (a b).....	.....	1871, Mar. 13
Eastman, John Robie.....	Naval Observatory. 2721 N St. N. W.	1871, May 27
Eaton, Amos Beebe (a b).....	.....	1871, Mar. 13
Eaton, John.....	Bureau of Education, Interior Dept. 712 East Capitol St.	1874, May 8
Eldredge, Stewart (c).....	.....	1871, June 9
Elliot, George Henry (a d).....	Engineer Bureau, War Department...	1871, Mar. 13
Elliott, Ezekiel Brown (a).....	Mint Bureau, Treasury Department. 607 I St. N. W.	1871, Mar. 13
Endlich, Frederic Miller.....	Smithsonian Institution.....	1873, Mar. 1
Ewing, Charles (c).....	.....	1874, Jan. 17
Ewing, Hugh (c).....	Lancaster, Ohio.....	1874, Jan. 17
Farquhar, Edward Jessop.....	Patent Office Library. 1915 H St. N. W.	1886, Feb. 12
Farquhar, Henry.....	Coast and Geodetic Survey Office. 726 20th St. N. W.	1871, Dec. 14
Ferrel, William.....	Coast and Geodetic Survey Office. 471 C St. N. W.	1872, Nov. 16
Fletcher, Robert.....	Surgeon Gen'l's Office. 314 Ind. Ave.	1873, Apr. 10
Flint, Albert Stowell.....	Naval Observatory. 1209 Rhode Island Ave. N. W.	1882, Mar. 25
Flint, James Milton.....	Smithsonian Inst. Riggs House.....	1881, Mar. 26
Foote, Elisha (a c).....	.....	1871, Mar. 13
Foster, John Gray (b).....	.....	1873, Jan. 18
French, Henry Flagg.....	Treasury Department. 137 East Cap- itol St.	1882, Mar. 25
Frisby, Edgar.....	Naval Observatory. 3006 P St. N. W.	1872, Nov. 16
Fristoe, Edward T.....	Columbian College. College Hill N. W.	1873, Mar. 29
Gale, Leonard Dunnell.....	1230 Mass. Ave. N. W.....	1874, Jan. 17
Gallaudet, Edward Miner.....	Deaf Mute College, Kendall Green.....	1875, Feb. 27
Gannett, Henry.....	Geological Survey. 1881 Harewood Ave., Le Droit Park.	1874, Apr. 11
Gardner, James Terry (c).....	State Library, Albany, N. Y.....	1874, Jan. 17
Garnett, Alexander Young P. (d)....	1317 N. Y. Ave. N. W.....	1878, Mar. 16
Gihon, Albert Leary.....	Navy Department. 1736 I St. N. W.....	1880, Dec. 18

NAME.	P. O. ADDRESS AND RESIDENCE.	DATE OF ADMISSION.
Gilbert, Grove Karl.....	Geological Survey. Le Droit Park....	1873, June 7
Gill, Theodore Nicholas (a).....	Smithsonian Inst. 321-323 4½ St. N. W.	1871, Mar. 13
Godding, William Whiting.....	Government Asylum for the Insane...	1879, Mar. 29
Goode, George Brown.....	National Museum. 1620 Mass. Av. N. W.	1874, Jan. 31
Goodfellow, Edward.....	Coast and Geodetic Survey Office.....	1875, Dec. 18
Goodfellow, Henry (d).....	Bureau of Military Justice, War Dept.	1871, Nov. 4
Gore, James Howard.....	Columbian College. 1305 Q St. N. W.	1880, Mar. 14
Graves, Edward Oziel (c).....	.....	1874, Apr. 11
Graves, Walter Hayden (c).....	Denver, Colorado.....	1878, May 25
Greely, Adolphus Washington (c).....	.....	1880, June 19
Green, Bernard Richardson.....	1738 N St. N. W.....	1879, Feb. 15
Green, Francis Mathews.....	Bureau of Navigation, Navy Dept.....	1875, Nov. 9
Greene, Benjamin Franklin (a c).....	West Lebanon, N. H.....	1871, Mar. 13
Greene, Francis Vinton.....	War Department. 1915 G St. N. W.....	1875, Apr. 10
Gunnell, Francis Mackall (c).....	600 20th St. N. W.....	1879, Feb. 1
Hains, Peter Conover (c).....	Office Light House Engineer, Charles- ton, S. C.	1879, Feb. 15
Hall, Asaph (a).....	Naval Observatory. 2715 N St. N. W.	1871, Mar. 13
Hanscom, Isaiah (b).....	.....	1873, Dec. 20
Harkness, William (a).....	Naval Observatory. 1415 G St. N. W.	1871, Mar. 13
Hassler, Ferdinand Augustus (c).....	Tustin City, Los Angeles Co., Cal.....	1880, May 8
Hayden, Ferdinand Vandever (ac).....	Geological Survey. 1803 Arch street, Philadelphia, Penna.	1871, Mar. 13
Hazen, Henry Allen.....	Army Signal Office. 1209 R. I. Av. N. W.	1882, Mar. 25
Hazen, William Babcock.....	Army Signal Office. 1601 K St. N. W.	1881, Feb. —
Henry, Joseph (a b).....	.....	1871, Mar. 13
Henshaw, Henry Wetherbee.....	Bureau of Ethnology. 903 M St. N. W.	1874, Apr. 11
Hilgard, Julius Erasmus (a).....	Coast and Geodetic Survey Office. 1709 Rhode Island Ave. N. W.	1871, Mar. 13
Hill, George William.....	Nautical Almanac Office. 318 Ind. Ave. N. W.	1879, Feb. 1
Holden, Edward Singleton (c).....	Madison, Wisconsin.....	1873, June 21
Holmes, William Henry.....	Geological Survey.....	1879, Mar. 29
Hough, Franklin Benjamin (c).....	Agricultural Department.....	1879, Mar. 29
Howell, Edwin Eugene (c).....	Rochester, N. Y.....	1874, Jan. 31
Howgate, Henry W.....	.....	1873, Jan. 18
Humphreys, Andrew Atkinson (a).....	S. E. Corner 15th and K Sts. N. W.....	1871, Mar. 13
Huntington, David Lowe.....	Army Med. Museum. 1709 M St. N. W.	1877, Dec. 21
Jackson, Henry Arundel Lambe (c).....	War Department.....	1875, Jan. 30
James, Owen (c).....	Hyde Park, Penna.....	1880, Jan. 3
Jeffers, William Nicolson (d).....	Navy Department.....	1877, Feb. 24
Jenkins, Thornton Alexander (a).....	2115 Penn. Ave. N. W.....	1871, Mar. 13
Johnson, Arnold Burgess.....	Light House Board, Treasury Dept. 501 Maple Ave., Le Droit Park.	1873, Jan. 19
Johnson, Joseph Taber.....	937 New York Ave. N. W.....	1879, Mar. 29
Johnston, William Waring.....	1401 H St. N. W.....	1873, Jan. 21
Kampf, Ferdinand (b).....	.....	1875, Dec. 18
Keith, Reuel (c).....	.....	1871, Oct. 29
Kidder, Jerome Henry.....	Navy Department. 1601 O St. N. W.	1880, May 8
Kilbourne, Charles Evans.....	Army Signal Office. Lexington House.	1880, June 19
King, Albert Freeman Africanus.....	726 13th St. N. W.....	1875, Jan. 16
King, Clarence (d).....	.....	1879, May 10
Knox, John Jay.....	Treasury Dept. 1127 10th St. N. W.....	1874, May 8
Kummell, Charles Hugo.....	Coast and Geodetic Survey Office. 608 Q St. N. W.	1882, Mar. 25
Lane, Jonathan Homer (a b).....	.....	1871, Mar. 13
Lawver, Winfield Peter.....	Mint Bureau, Treasury Department. 1912 I St. N. W.	1881, Feb. 19
Lee, William.....	2111 Penn. Ave. N. W.....	1874, Jan. 17
Lincoln, Nathan Smith.....	1514 H St. N. W.....	1871, May, 27
Lockwood, Henry H. (d).....	.....	1871, Oct. 29
Loomis, Eben Jenks.....	Nautical Almanac Office. 1413 College Hill Terrace N. W.	1880, Feb. 14
Lull, Edward Phelps.....	Navy Department. 1313 M St. N. W.....	1875, Dec. 4
Lyford, Stephen Carr (d).....	Ordnance Office, War Department.....	1873, Jan. 18
Macauley, Henry Clay (c).....	.....	1880, Jan. 3
McGuire, Frederick Bauders.....	1306 F St. N. W. Res., 614 E St. N. W.	1879, Feb. 16
Mack, Oscar A. (b).....	.....	1872, Jan. 27
McMurtrie, William.....	Agricultural Dept. 1728 I St. N. W.....	1876, Feb. 26

NAME.	P. O. ADDRESS AND RESIDENCE.	DATE OF ADMISSION.
Mallery, Garrick.....	Bureau of Ethnology. P. O. Box 585. Res., 1323 N St. N. W.	1875, Jan. 30
Marvin, Joseph Badger (c).....		1878, May 25
Marvine, Archibald Robertson (b).....		1874, Jan. 31
Mason, Otis Tufton.....	Columbian College. 1305 Q St. N. W.	1875, Jan. 30
Meek, Fielding Bradford (a b).....		1871, Mar. 13
Meigs, Montgomery (c).....	War Department. Rock Island, Ill.	1877, Mar. 24
Meigs, Montgomery Cunningham (a).....	1239 Vermont Ave. N. W.	1871, Mar. 13
Menocal, Aniceto Garcia.....	Navy Yard, Washington, D. C.	1877, Feb. 24
Mew, William Manuel.....	Army Medical Museum. 942 New York Ave. N. W.	1873, Dec. 20
Milner, James William (b).....		1874, Jan. 31
Morris, Martin Ferdinand (c).....	717 12th St. N. W.	1877, Feb. 24
Mussey, Reuben Delavan.....	P. O. Box 618. Res., 508 5th St. N. W.	1881, Dec. 3
Myer, Albert J. (a b).....		1871, Mar. 13
Myers, William (c).....	Office of Commissary General, War Department.	1871, June 23
Newcomb, Simon (a).....	Navy Department. 1336 11th St. N. W.	1871, Mar. 13
Nichols, Charles Henry (c).....		1872, May 4
Nicholson, Walter Lamb (a).....	Topographer of Post Office Dept. 1322 I St. N. W.	1871, Mar. 13
Nordhoff, Charles.....	New York Herald Bureau. 1027 New York Ave. N. W.	1879, May 10
Osborne, John Walter.....	212 Delaware Ave. N. E.	1878, Dec. 7
Otis, George Alexander (a b).....		1871, Mar. 13
Packard, Robert Lawrence (c).....	Patent Office. 2022 G St. N. W.	1875, Feb. 27
Parke, John Grubb (a).....	Engineer Bureau, War Department. 16 16½ St. N. W.	1871, Mar. 13
Parker, Peter (a).....	2 La Fayette Square	1871, Mar. 13
Parry, Charles Christopher (c).....	Burlington, Iowa.	1871, May 13
Patterson, Carlile Pollock (b).....		1871, Nov. 17
Paul, Henry Martyn (c).....	University of Tokio, Japan.	1877, May 19
Peale, Albert Charles (c).....	Schuylkill Haven, Schuylkill Co., Pa.	1874, Apr. 11
Peale, Titian Ramsay (a c).....		1871, Mar. 13
Peirce, Benjamin (a b).....		1871, Mar. 13
Peirce, Charles Sanders (c).....	Coast and Geodetic Survey Office. Res., Baltimore, Md.	1873, Mar. 1
Pilling, James Constantine.....	Geological Survey. 903 M St. N. W.	1881, Feb. 19
Poe, Orlando Metcalfe.....	Headquarters of the Army. 1507 Rhode Island Ave. N. W.	1873, Oct. 4
Porter, David Dixon (d).....	1710 H St. N. W.	1874, Apr. 11
Powell, John Wesley.....	Geological Survey. 910 M St. N. W.	1874, Jan. 17
Prentiss, Daniel Webster.....	1224 9th St. N. W.	1880, Jan. 3
Pritchett, Henry Smith (c).....	Washington University, St. Louis, Mo.	1879, Mar. 29
Rathbone, Henry Reed (c).....		1874, Jan. 17
Ridgway, Robert (c).....	Smithsonian Inst. 1214 Va. Av. N. W.	1874, Jan. 31
Riley, Charles Valentine.....	Agricultural Dept. 1700 13th St. N. W.	1878, Nov. 9
Riley, John Campbell (b).....		1877, May 19
Ritter, William Francis McKnight.....	Nautical Almanac Office. 16 Grant Place.	1879, Oct. 21
Rodgers, Christopher Raymond Perry (c).....	1723 I St. N. W.	1872, Mar. 9
Rodgers, John (b).....		1872, Nov. 16
Rogers, Joseph Addison (c).....	Naval Observatory.....	1872, Mar. 9
Russell, Israel Cook.....	Geological Survey.....	1882, Mar. 25
Sands, Benjamin Franklin (a).....	816 15th St. N. W.	1871, Mar. 13
Saville, James Hamilton.....	342 D St. (La. Ave.) N. W. Res., 1315 M St. N. W.	1871, Apr. 29
Sawyer, Frederic Adolphus (c).....		1873, Oct. 4
Schaeffer, George Christian (a b).....		1871, Mar. 13
Schoff, Charles Anthony (a).....	Coast and Geodetic Survey Office. 212 1st St. S. E.	1871, Mar. 13
Searle, Henry Robinson.....	1223 10th St. N. W.	1877, Dec. 21
Seymour, George Dudley.....	607 7th St. N. W. Res., 1007 9th St. N. W.	1881, Dec. 3
Shellabarger, Samuel.....	Room 23, Corcoran Building. Res., 812 17th St. N. W.	1875, Apr. 10
Sherman, John.....	1317 K St. N. W.	1874, Jan. 17
Sherman, William Tecumseh (a d).....	War Department. 817 15th St. N. W.	1871, Mar. 13
Shufeldt, Robert Wilson.....	Surg. Genl's Office. 819 17th St. N. W.	1881, Nov. 6

NAME.	P. O. ADDRESS AND RESIDENCE.	DATE OF ADMISSION.
Sicard, Montgomery (c).....	Ordnance Bureau, Navy Department. 1404 L St. N. W.	1877, Feb. 24
Sigsbee, Charles Dwight.....	Hydrographic Office, Navy Dept. 3319 U St., West Washington.	1879, Mar. 1
Skinner, Aaron Nicholas (c).....	Naval Observatory. 1726 10th St. N.W.	1875, Feb. 27
Smith, David (c).....	Navy Department.....	1876, Dec. 2
Smith, Edwin.....	Coast and Geodetic Survey	1880, Oct. 23
Spofford, Ainsworth Rand.....	Library of Congress. 1621 Mass. Ave. N. W.	1872, Jan. 27
Stearns, John (c).....	.....	1874, Mar. 28
Stone, Ormond (c).....	Leander McCormick Observatory, University of Virginia.	1874, Mar. 28
Story, John Patten.....	Army Signal Office. 921 17th St. N.W.	1880, June 19
Taylor, Frederick William.....	Smithsonian Institution. 1120 Ver- mont Ave. N. W.	1881, Feb. 19
Taylor, George (c).....	804 E St. N. W. Res., 1120 Vermont Ave. N. W.	1873, Mar. 1
Taylor, William Bower (a)	Smithsonian Inst. 457 C St. N. W.....	1871, Mar. 13
Thompson, Almon Harris (c).....	Ivanpah, Greenwood Co., Kansas.....	1875, Apr. 10
Tilden, William Calvin (c).....	Army Medical Museum.....	1871, Apr. 29
Todd, David Peck (c).....	Amherst, Mass.....	1878, Nov. 23
Toner, Joseph Meredith.....	615 Louisiana Ave.....	1873, June 7
Twining, William J. (b).....	.....	1878, Nov. 23
Upton, Jacob Kendrick (d)	Cooke & Co., cor. 15th St. and Penn. Ave. 1721 De Sales St.	1878, Feb. 2
Upton, William Wirt.....	2d Comptroller's Office, Treasury Dept. 810 12th St. N. W.	1882, Mar. 25
Upton, Winslow.....	Army Signal Office. 1441 Chapin St. N. W.	1880, Dec. 4
Vasey, George.....	Agricultural Dept. 1437 S St. N. W....	1875, June 5
Waldo, Frank.....	Army Signal Office. 1427 Chapin St. N. W.	1881, Dec. 3
Walker, Francis Amasa (c).....	Mass. Inst. of Technology, Boston, Mass.	1872, Jan. 27
Ward, Lester Frank.....	Geological Survey. 1464 R. I. Av. N.W.	1876, Nov. 18
Warren, Charles (e).....	Bureau of Education. 1208 N St. N. W.	1874, May 8
Webster, Albert Lowry.....	Geological Survey. P. O. Box 591.....	1882, Mar. 25
Welling, James Clarke.....	Columbian College.....	1872 Nov. 16
Wheeler, George M. (c).....	Engineer Bureau, War Department...	1873, June 7
Wheeler, Junius B (a c).....	West Point, New York	1871, Mar. 13
White, Charles Abiathar.....	Geological Survey. Le Droit Park.....	1876, Dec. 16
White, Zebulon Lewis (c).....	Providence, Rhode Island	1880, June 19
Wilson, Allen D.....	Geological Survey.....	1874, Apr. 11
Wilson, James Ormond.....	Franklin School Building. 1439 Mass. Ave. N. W.	1873, Mar. 1
Winlock, William Crawford.....	Naval Observatory. 1903 F St. N. W.	1880, Dec. 4
Wolcott, Christopher Columbus (d)	War Department.....	1875, Feb. 27
Wood, Joseph (c).....	Asst. Engineer B. & P. R. R.	1875, Jan. 16
Wood, William Maxwell (c).....	Navy Department.....	1871, Dec. 2
Woodward, Joseph Janvier (a).....	Army Med. Museum. 620 F St. N. W.	1871, Mar. 13
Woodworth, John Maynard (b).....	.....	1874, Jan. 31
Yarnall, Mordecai (b).....	.....	1871, Apr. 29
Yarrow, Harry Crécy.....	814 17th St. N. W.....	1874, Jan. 31
Zumbrock, Anton.....	Coast and Geodetic Survey Office. 306 C St. N. W.	1875, Jan. 30

Number of founders.....	44
“ members deceased	23
“ “ absent	52
“ “ resigned.....	12
“ “ dropped.....	5
“ “ active.....	149
Total number enrolled.....	246



BULLETIN

OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON.

203D MEETING.

OCTOBER 8, 1881.

The Society, in accordance with the notice of adjournment at its last June meeting, resumed its sessions.

The President (Mr. J. J. WOODWARD) in the Chair.

Thirty-eight members present.

Mr. G. K. GILBERT read a communication on

THE QUATERNARY CLIMATE OF THE GREAT BASIN.

The matters contained in this communication were a summary of certain chapters which will appear from the pen of Mr. Gilbert in the Second Annual Report of the Director of the United States Geological Survey now in press. The observations of which the communication was a resume were made in his capacity of Geologist in charge of the Exploration of the Utah Division.

Remarks were made on Mr. Gilbert's communication by Mr. THOMAS ANTISELL.

Mr. E. B. ELLIOTT also made a communication on

ACCRUED INTEREST ON GOVERNMENT SECUTITIES.

Mr. W. B. TAYLOR exhibited to the Society a photographic print from a single negative including about 140 degrees of panorama. The ordinary camera does not usually comprise more than about 60 degrees, and requires as a necessary condition of good definition

perfect stability of the lens and the plate. In the present case, an inspection of the two houses presented in the rural view, (especially of the longer one near the middle of the picture,) with the curved road winding between them to the right, shows that a revolving camera was employed; the long sensitive plate having evidently been simultaneously moved transversely in the reverse direction to that of the objective. This perfect co-ordination of the revolving and sliding movements could be obtained by a mechanical gearing; and the extended landscape be thus successively impressed upon advancing portions of the plate—probably through a vertical slit in a diaphragm immediately in front of the plate. That the correlation of movement has been very perfect is evidenced by the admirable precision of every detail in the photograph. It will be observed that the three men standing in different parts of the field of view are one and the same individual, who has had time to pass behind the instrument, and to twice take a new position in advance of the moving camera. By bending the long card into a concave arc somewhat more than the third of a cylinder, and placing the eye at the axis of curvature; it will be seen that the various slight distortions of perspective (particularly in the houses) are completely corrected.

Mr. J. M. TONER exhibited, *apropos* to the approaching centennial of the surrender of Cornwallis at Yorktown, certain well preserved specimens of coins and medals of national historic interest, viz:

- (1.) Bronze copy of medal given to Washington on the evacuation of Boston.
- (2.) A bronze copy of a medal of Lafayette.
- (3.) A bronze copy of a medal of Columbus.
- (4.) A very fine half dollar of 1785.
- (5.) A very fine Washington cent of 1791.

204TH MEETING.

OCTOBER 22, 1881.

The President in the Chair.

Forty members present.

Mr. A. B. JOHNSON presented the following communication on

RECENT INVESTIGATIONS BY THE LIGHT-HOUSE BOARD ON THE
ANOMALIES OF SOUND FROM FOG SIGNALS.

Among our erroneous popular notions is one which occasionally brings practical men, even ship-masters, to grief. It is the idea that sound is always heard in all directions from its source according to its intensity or force, and according to the distance of the hearer from it. Instances of this fallacy have accumulated, and they are emphasized by shipwrecks caused by the insistence of mariners on the infallibility of their ears, who have accepted unquestioned the guidance of sound signals during fog as they have that of light-houses during clear weather. The fact is, audition is subject to aberrations, and under circumstances where little expected. We have learned by sad experience that implicit reliance on sound signals may, as it has, lead to danger if not to death.

The wreck of the steamer Rhode Island, on Bonnet Point in Narragansett Bay, which happened on November 6, 1880, when a million dollars in property was lost, was caused, it was said, by the failure of the fog-signal on Beaver Tail Point to sound at that time. Thereupon the Light-House Board, which has charge of the sixty and more fog-signals on our coasts, made an investigation which showed that the fog-signal was in full operation when the wreck took place; but it also brought out the fact, that while there was no lack in the volume of the sound emitted by the signal, there was often a decided lack in the audition of that sound, so much so that it would not be heard at the intensity expected, nor at the place expected; indeed it would be heard faintly where it ought to be heard loudly, and loudly where it ought to be heard faintly; that it could not be heard at all at some points, and then further away it could be heard better than near by; that it could be heard and lost and heard and lost again, all within reasonable ear shot, and all this while the signal was in full blast and sounding continuously.

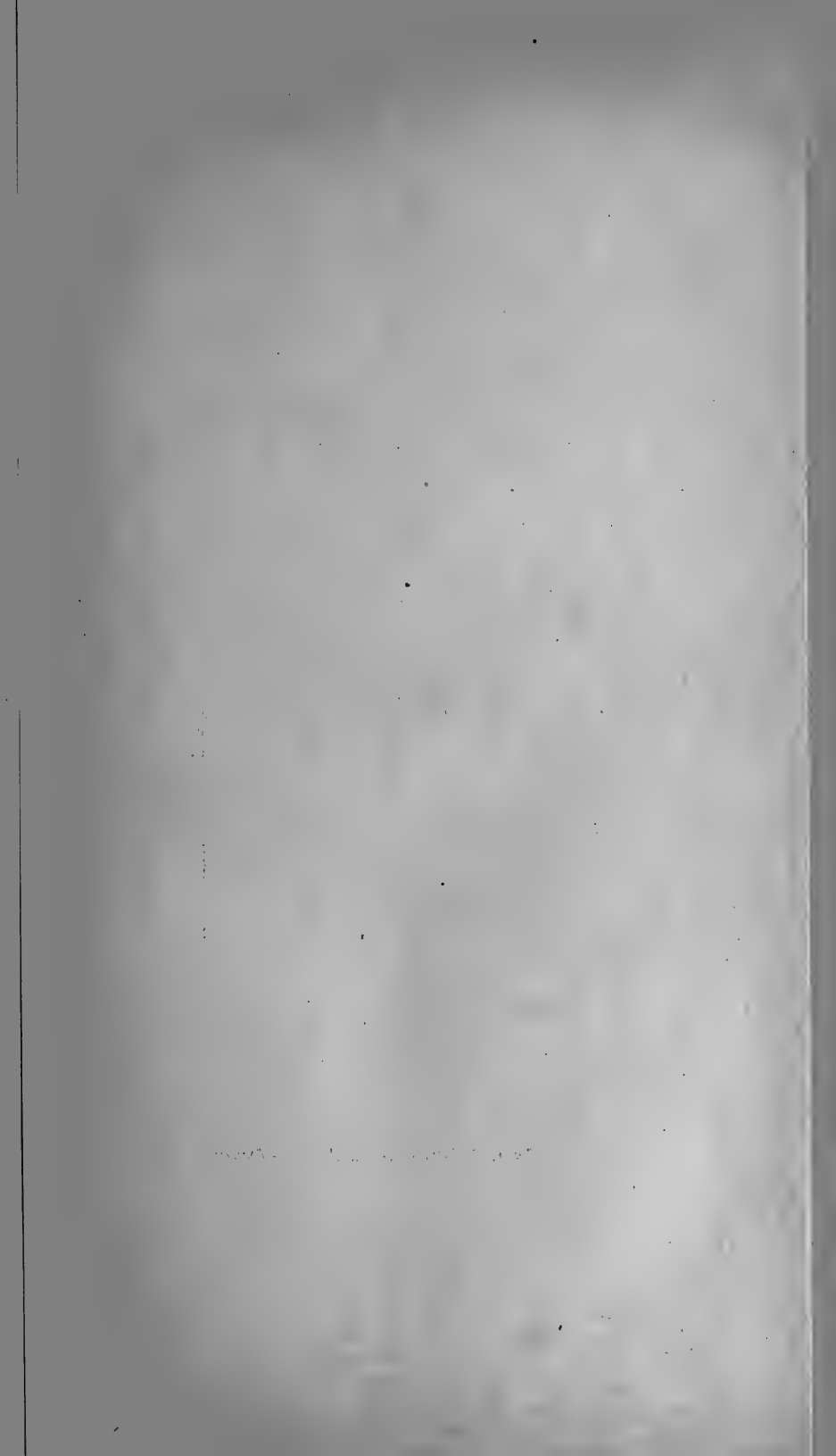
The following table, A, will give the results obtained by the officer of the navy who investigated these phenomena, and reported to the Light-House Board:

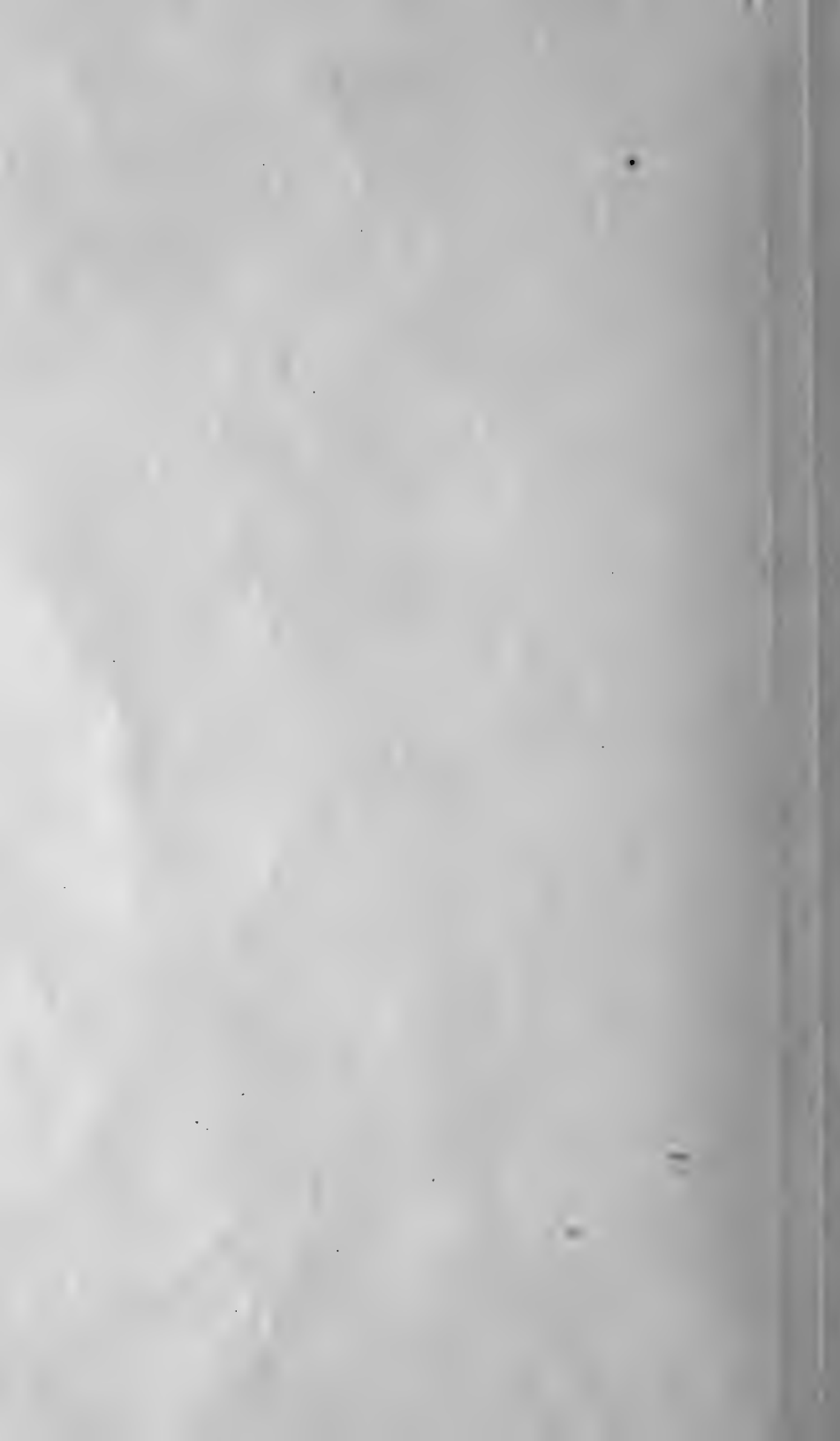
TABLE A.

Observations on Beaver Tail Fog-Signal, Rhode Island, made on November 16, 1880, from a sail-boat, Thermometer at beginning 58°, ending 67°; Wind moderate from the West; Weather clear and cold, with a bright sun. Time, beginning 11.15 A. M.

Number of Observation.	Distance from Beaver Tail Fog-Signal in statute miles.	Intensity of sound in scale of 10.	REMARKS.
1	$\frac{1}{2}$	10	
2	$\frac{2}{8}$	2	
3	$1\frac{1}{4}$	1	
4	$1\frac{1}{4}$	10	
5	$1\frac{3}{8}$	1	
6	$1\frac{1}{2}$	0	
7	$1\frac{3}{8}$	0	
8	$1\frac{7}{8}$	1	Close to Bonnet Point changed course and ran almost due south.
9	$1\frac{1}{8}$	1	$1\frac{1}{2}$ miles from last station.
10	1	0	$\frac{1}{4}$ mile from last station.
11	$\frac{7}{8}$	1	" " "
12	$\frac{5}{8}$	4	" " "
13	$\frac{1}{2}$	10	" " "
14	$\frac{3}{8}$	10	About opposite Beaver Tail, $\frac{1}{2}$ mile from last station, and in the axis of trumpet.
15	$\frac{1}{2}$	10	About $\frac{1}{2}$ mile from last station, and running for Newport, heading nearly northeast.
16	1	10	About $\frac{1}{2}$ mile from last station.
17	$1\frac{1}{4}$	5	" $\frac{1}{2}$ " "
18	$1\frac{1}{2}$	2	" $\frac{1}{4}$ " "
19	$1\frac{7}{8}$	2	" $\frac{1}{4}$ " "
20	$2\frac{1}{8}$	1	" $\frac{1}{2}$ " "
21	$2\frac{1}{2}$	0	" $\frac{1}{4}$ " "
22	$3\frac{1}{2}$	0	" $\frac{1}{2}$ " "
23	$3\frac{3}{8}$	2	" $\frac{1}{2}$ " "
24	4	10	About $\frac{1}{4}$ mile from last station, just off Ft. Adams.
25	$4\frac{1}{4}$	10	Under the lee of Fort Adams.
26	$4\frac{1}{2}$	2	
27	$4\frac{5}{8}$	2	
28	$4\frac{3}{4}$	2	
29	5	2	Newport.

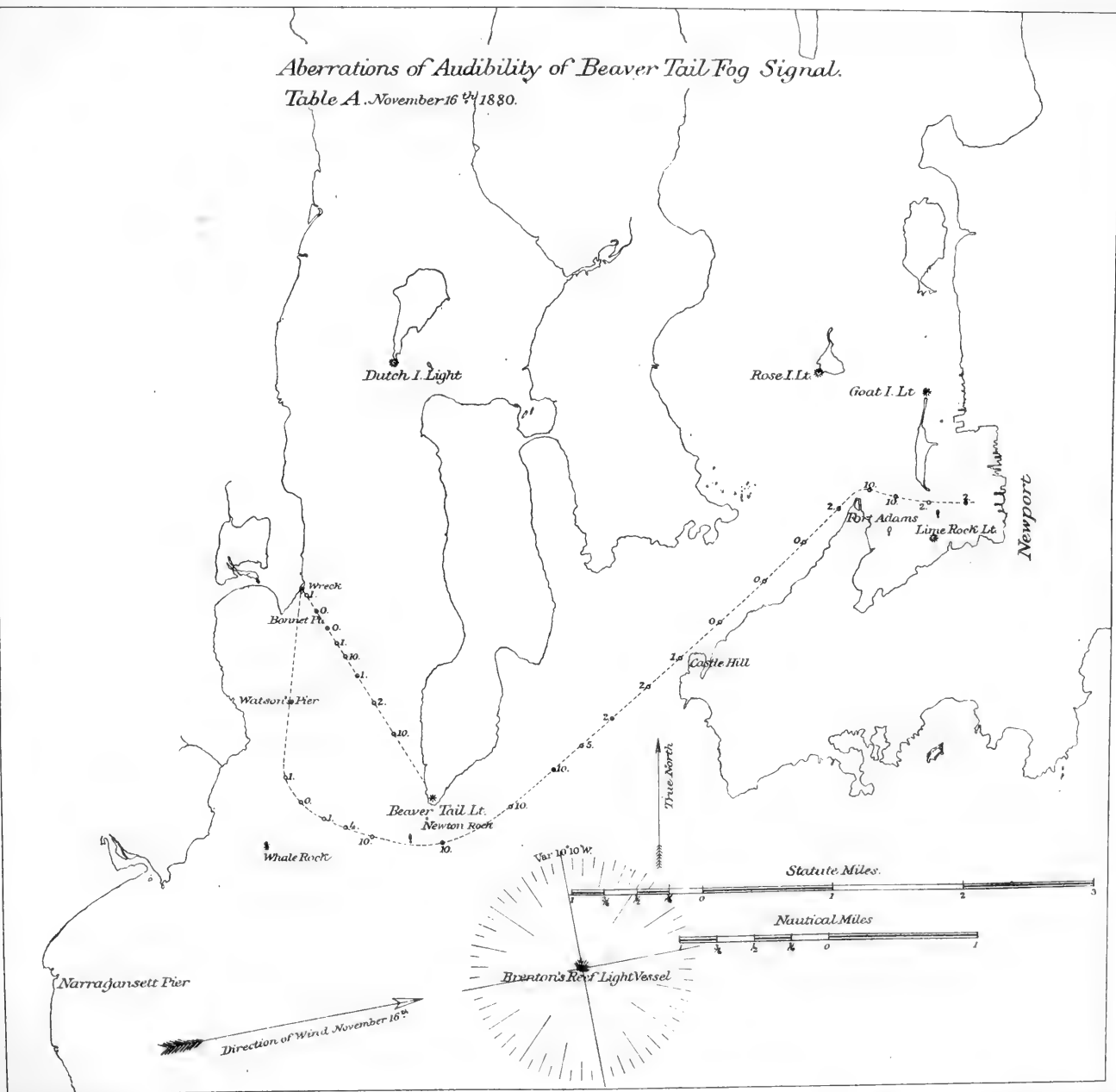
Last summer, I had an opportunity while on a light-house steamer, to experience something of the variations in the audition of the Beaver Tail fog-signal. When the steamer left the light-

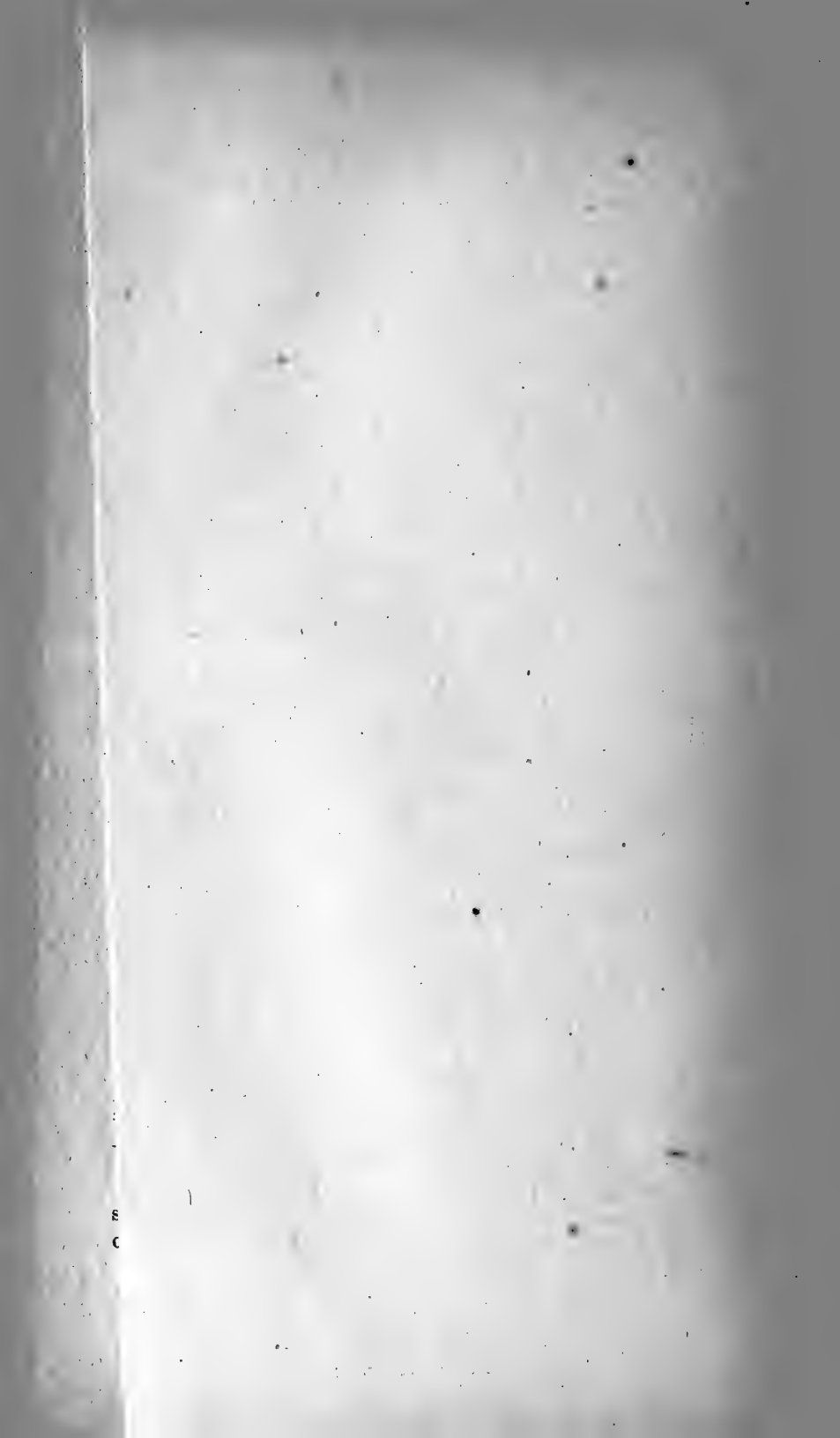




Aberrations of Audibility of Beaver Tail Fog Signal.

Table A. November 16th 1880.





house landing, the fog-signal was to sound for a given time, and to commence when the steamer had reached a given point, half a mile distant. When that point was reached, we could see by the steam-puffs coming from the 'scape pipe, that the signal was being blown; but we could not hear its sound; nor did we, as we continued on our course, running away from the light station for the next five minutes. When near to Whale Rock, less than a mile and a half distant from the signal, the steamer was stopped, silence was ordered fore and aft, and we all listened intently. The expert naval officers thought they heard a trace of the fog-signal, but my untrained ears failed to differentiate it from the moan of the whistling buoy close to us. Yet the blasts of the ten-inch steam whistle, for which we were listening, can often be heard at a distance of ten miles.

Soon after, I had another opportunity to further observe the operations of this signal. We left Narragansett Pier, R. I., on Aug. 6, 1881, at 4 P. M., in a dense fog, with a strong breeze from the W. S. W., and a heavy chop sea. We wished to ascertain how far the Beaver Tail fog-signal could be heard dead to windward and in the heaviest of fogs. At Whale Rock, one and one-third miles from it, we did not hear a trace of it. Then the steamer was headed directly for Beaver Tail Point, and we ran slowly for it by compass, until the pilot stopped the steamer, declaring we were almost aboard of the signal itself. Every one strained his ears to hear the signal but without success; and we had begun to doubt of our position when, the fog lifting slightly, we saw the breakers in altogether too close proximity for comfort. We passed the point as closely as was safe; and, when abreast of it and at right angles with the direction of the wind, the sound of the fog-signal broke on us suddenly and with its full power. We then ran down the wind to Newport, and carried the sound with us all the way. The fog continuing during the next day, the signal kept up its sound, and we heard it distinctly and continuously at our wharf, though five miles distant.

On the night of May 12, 1881, about midnight, the *Galatea*, a propeller of over 1500 tons burden, with a full load of passengers and freight, bound through Long Island Sound from Providence to New York, grounded in a dead calm and a dense fog on Little Gull Island, about one-eighth of a mile from and behind the fog-signal, and got off two days later without damage to herself or loss

of life or freight. It was as usual alleged that the fog-signal, a steam siren, at Little Gull Light, was not in operation at the time of the accident, and the Light-House Board, also, as usual, immediately ordered an investigation. This was made by the Assistant Inspector of the Light-House District, a naval officer, who reported that after taking the sworn evidence of the light-keepers at Little Gull and the other light-stations within hearing distance, of other Government officers who were, for the time being, so located that they might have had knowledge of the facts, and of the officers of vessels that were within ear shot, including those of the Galatea, he reached the conclusion that the fog-signal was sounding at the time of the accident; and that, although the fog-signal was heard at Mystic, fifteen miles distant in another direction, and although it was heard on a steam tug a mile beyond the Galatea; that it was heard faintly, if at all, on that vessel; and if heard at all, was so heard as to be misleading, though the Galatea was but one-eighth of a mile from the source of the sound.

This report is in itself full of interest. It appears that this officer spent several days steaming around Little Gull, while the fog-signal was in full blast, in various kinds of weather, and that he found the aberrations in audition here were as numerous and even more eccentric than those before mentioned as experienced at Beaver Tail. The results of his observations are given in Tables B and C; and in each case the condition of the atmosphere as to humidity, pressure, temperature and motion are shown, as is also the then tidal condition.

TABLE B.

Fog Signal Tests at Little Gull Island, Long Island Sound, July 11, 1881.
Time 10 A. M. Wind, N.N.E., force 2. Barometer, 29.77; Thermometer, 61. Weather at commencement, dark, overcast with squalls of Scotch mist from N.N.E. It began to clear at 11:30 A.M.

Number of Observation.	Time of Observation.	Distance from Little Gull Island fog signal in stat. miles.	Intensity of sound in scale of ten.	REMARKS.
	<i>h. m.</i>			
1	10 10	1 $\frac{5}{8}$	1	A faint murmur is put at $\frac{1}{2}$ of 1, in scale of 10.
2	10 15	2 $\frac{3}{8}$	$\frac{1}{2}$	
3	10 18	2 $\frac{1}{2}$	0	
4		3 $\frac{3}{8}$	0	

Number of Observation.	Time of Obser- vation.	Distance from Little Gull Is- land fog signal in stat. miles.	Intensity of sound in scale of ten.	REMARKS.
5	<i>h. m.</i>			
6	10 25	$3\frac{3}{8}$	0	
7		$3\frac{1}{2}$	0	
8		$3\frac{1}{2}$	$\frac{1}{2}$	About $\frac{1}{2}$ mile from last station.
9	10 50	$3\frac{1}{2}$	1	
10		$3\frac{3}{8}$	0	About $\frac{1}{2}$ mile from last station.
11		$3\frac{3}{4}$	1	About $\frac{1}{2}$ mile from last station.
12	11 09	$3\frac{1}{2}$	2	Changed course and ran a little S. of W.
13		$3\frac{3}{4}$	2	
14	11 15	$2\frac{7}{8}$	3	
15	11 25	$2\frac{1}{2}$	3	
16		$2\frac{3}{4}$	4	
17	11 35	$2\frac{1}{2}$	5	
18		$2\frac{1}{2}$	7	
19		$2\frac{1}{2}$	7	
20	11 55	$1\frac{1}{2}$	8	
21		$\frac{1}{2}$	9	
22	12 03	$\frac{1}{2}$	10	About $\frac{1}{2}$ mile from last station.
23	12 07	$\frac{3}{8}$	10	
24		$\frac{3}{8}$	7	
25	12 14	$1\frac{7}{8}$	2	
26	12 19	$1\frac{7}{8}$	1	
27	12 23	$2\frac{1}{4}$	$1\frac{1}{2}$	Changed course.
28	12 40	$2\frac{3}{4}$	$\frac{1}{2}$	Faint murmur.
29	12 52	$3\frac{1}{2}$	$\frac{1}{2}$	Changed course.
30	1 01	2	0	
31	1 06	$1\frac{5}{8}$	$\frac{1}{2}$	
32	1 12	$1\frac{5}{8}$	1-2	
33	1 18	$\frac{3}{4}$	5	
34		$\frac{5}{8}$	10	Almost west of fog-signal.
35		$1\frac{1}{4}$	10	
36	1 35	$1\frac{1}{2}$	10	Changed course.
37		$1\frac{5}{8}$	8	
38	1 42	$\frac{7}{8}$	8	
39	1 52	$\frac{1}{2}$	10	Stood N. E.; sound gradually increasing.
40	1 55	$\frac{7}{8}$	3	
41		$\frac{3}{4}$	2	Changed course.
42	2 01	$\frac{3}{4}$	2	
43	2 02	$\frac{7}{8}$	2	
44		$\frac{1}{8}$	10	
45		$\frac{3}{8}$	10	
46		$\frac{3}{4}$	8	
47		1	7	
48	4 29	$1\frac{3}{4}$	5	
49		2	2	
50	4 38	$2\frac{3}{4}$	1	
51		$3\frac{3}{8}$	0	Lost the sound.
52	4 45	$3\frac{3}{4}$	0	Bartlett's Reef light-ship; wheels stopped and no sound.

TABLE C.

Observations at Little Gull Island, Long Island Sound, July 15, 1881, commencing at 6.30 A. M. Thermometer, 59° Fahr. Barometer, 29.80. Wind, W.N.W., force 3, hauling to the westward and increasing gradually.

Number of Observation.	Time of Observation.	Distance from Little Gull Island fog-signal in stat. miles.	Intensity of sound in a scale of ten.	REMARKS.
1	<i>h. m.</i> 6 32	1 $\frac{3}{4}$	10	
2	6 57	2 $\frac{1}{4}$	10	Changed course, running S. by W. $\frac{1}{2}$ W.
3		2 $\frac{1}{4}$	8	About $\frac{1}{2}$ mile from last station.
4		2 $\frac{3}{8}$	7	
5		3 $\frac{1}{4}$	4	
6	7 17	3 $\frac{3}{4}$	3	Changed course, running E.
7		3 $\frac{3}{8}$	2	About $\frac{1}{2}$ mile from last station.
8		3 $\frac{3}{4}$	1	" " "
9		3 $\frac{1}{2}$	5	" " "
10	7 28	3 $\frac{3}{8}$	7	Changed course, running N. by W. $\frac{1}{2}$ W.
11		2 $\frac{1}{2}$	8	
12		2 $\frac{1}{2}$	5	About $\frac{1}{2}$ mile from last station.
13		2	5	Changed course, running W.
14	7 50	2 $\frac{3}{4}$	5	
15		2 $\frac{7}{8}$	3	
16		3 $\frac{1}{8}$	2	
17	8 00	3 $\frac{3}{4}$	0	Sound lost.

On August 3d, I had an opportunity to hear this fog-signal myself, and to note its audibility. The wind was from the south and very light; the air was damp, smoky, hazy, and, as the sailors say, hung low; the barometer stood at 29.90; the tide was about flood. Our steamer was run for six miles in the axis of the siren's trumpet, which was sounded for our benefit at its full force. Note was made every third minute in a scale of ten of the intensity of the sound, and it was found that the audition decreased normally with the distance for the first two miles; at 2 $\frac{1}{4}$ miles it had fallen off one-half; at 3 miles it had fallen to one-tenth its power; at 3 $\frac{1}{4}$ miles away we could hear but a faint murmur, and when 4 miles distant, we had lost it completely; and yet there seemed to be no reason why we should not have heard it clearly at three times that distance.

The next morning was calm, but heavy with white fog; yet we heard the Little Gull siren distinctly though it was 10 $\frac{1}{2}$ miles off, as we lay at our dock in New London. The steamer ran out of the

harbor, but was compelled to anchor so thick was the fog ; yet we heard Little Gull though $7\frac{1}{2}$ miles off, at a force of 6 in the scale of ten, and the sound was so clear cut and distinct that we could differentiate it from the siren at the New London light, which was much nearer to us. The steamer worked round to inspect the neighboring lights, and we heard the Little Gull siren when at North Dumpling light station, 7 miles off, at a force of 6 ; at Morgan's Point Light, 10 miles off, at a force of 5, and we continued to hear it at an intensity of from 5 to 6 as we worked around among the other lights, within a compass of 10 miles, till the fog broke and the siren ceased.

Opportunity soon occurred for making more critical experiments. On a fine day we ran out to Little Gull, had the siren started under full steam, and then, following out a pre-arranged program, ran round Little Gull Island in such way, as to describe a rectangle of about 8 by 10 miles, its longest side running nearly north and south. No fixed rate of speed was maintained, but the steamer slowed, backed, or stopped, as was necessary. The atmosphere was what the sailors call lumpy, and Prof. Tyndall calls non-homogeneous. Prof. Henry, when writing of a like condition, said : * " As the heat of the sun increases during the first part of the day, the temperature of the land rises above that of the sea, and this excess of the temperature *produces upward currents of air*, disturbing the general flow of wind, both at the surface of the sea and at an elevation above." Observations were made and noted in a scale of ten, of the force or intensity of the signal's sound as it reached us at the end of each minute. The following Table D shows a sufficient number of the results for our purposes, taken from the tabulated schedule of our notes. The table also shows the condition of the atmosphere during our observations.

*L. H. Board's Rep. for 1875, page 116.

TABLE D.

Observations at Little Gull Island, Long Island Sound, August 9, 1881, commencing at 10 A. M. Thermometer—Dry Bulb, 73°.09, Wet Bulb, 73° Fahr. Barometer, 29.77 Wind, S.W., force, 3. Cir. Strat. Clouds about the horizon.

Number of Observation.	Time of Observation.	Distance from Little Gull Island in statute miles.	Intensity of sound in scale of ten.	Number of Observation.	Time of Observation.	Distance from Little Gull Island in statute miles.	Intensity of sound in scale of ten.
	<i>h. m.</i>				<i>h. m.</i>		
1	10 30	0 $\frac{1}{4}$	10	16	12 04	2 $\frac{5}{8}$	9
2	10 32	0 $\frac{1}{3}$	10	17	12 08	2 $\frac{1}{4}$	9
3	10 34	0 $\frac{1}{2}$	10	18	12 13	2 $\frac{1}{8}$	5
4	10 36	1	10	19	12 20	2 $\frac{1}{8}$	3
5	10 37	1 $\frac{1}{4}$	0	20	12 28	3 $\frac{1}{4}$	1
6	10 48	2	0	21	12 35	3 $\frac{1}{2}$	0 $\frac{1}{2}$
7	10 57	3	0	22	12 41	3 $\frac{3}{8}$	0
8	11 02	3	0	23	12 45	3	1
9	11 08	3 $\frac{1}{8}$	1	24	12 57	2 $\frac{1}{2}$	0
10	11 15	3 $\frac{1}{2}$	3	25	12 58	2 $\frac{3}{8}$	0
11	11 23	4 $\frac{1}{8}$	4	26	1 02	1 $\frac{1}{2}$	1
12	11 38		8	27	1 20	1 $\frac{3}{4}$	0 $\frac{1}{2}$
13	11 42	2 $\frac{3}{4}$	9	28	1 24	1 $\frac{5}{8}$	0 $\frac{1}{2}$
14	11 54	3	9	29	1 30	0 $\frac{3}{4}$	0
15	11 57	3 $\frac{1}{4}$	9	30	1 32	0 $\frac{1}{4}$	10

At 4 P. M. two of us went in a row boat to Little Gull from the steamer which lay to her anchor half a mile off, and verified the fact that the fog-signal had been in full operation during the time of our observations by the report of the steamer's mate, who had been left there for that purpose. It then occurred to us to investigate still more closely what appeared to be a space—a circle of silence—in which we had, during the experiments of the morning, failed to hear the signal. After having had the siren put in full operation again, we pulled toward the nearer end of Great Gull Island, the siren sounding meantime with earsplitting force. When about 600 yards away we suddenly lost the sound as completely as if the signal had stopped. Pulling toward the steamer, not more than 200 yards, we reached a position at right angles with the axis of the siren's trumpet when we suddenly heard the sound again at its full force. Thus, in pulling 500 yards, we passed from complete audition of the signal to absolute inaudition; and then we passed back again to complete audition by pulling 200 yards in

another direction. All this took place within half an hour in open water, always in full view of the signal station, and without any visible obstacle being interposed or removed.

While on the island we learned that one of the light-house keepers, who had been on leave, had just returned from Sag Harbor, twenty miles away to the southeast. He had failed to hear the signal at all, until opposite the eastern end of Great Gull Island, and until he was within half a mile of the siren which was in full operation.

On the next morning our steamer anchored about a mile north of Little Gull; the wind was light, the air was clear, and the day was warm and beautiful. As it had been preceded by a warm night the atmosphere was homogeneous, and it was expected that we should have a day of normal audition and barren of curious phenomena. After the siren had commenced its noise we ran down to a point within half a mile of the light-house, and then steamed for Plum Island, running a little south of east for six miles, when we returned as nearly as might be on our own track. The results were curious. We lost half the force of the sound when within a quarter of a mile of the siren; a moment later we had lost four-fifths of it. Running another half mile we were off the middle of Great Gull Island, and the sound had increased to a force of four; in five minutes more it had dropped to three; from that on, until we reached the end of our six mile run, it gradually weakened, and it had dropped to a force of two when we turned and ran back to our anchorage. It is particularly curious that the sound had the same intensity at three-sixteenths of a mile from its source, and at six whole miles from that point, while it varied from two to ten in a scale of ten between those points. The results of the trip are more fully and exactly given in Table E.

Thinking that possibly this peculiarity might have been induced by those differences of temperature in the strata of the atmosphere suggested by Dr. Tyndall as probable cause for such phenomena, effort was made to ascertain something of these differences by sending a thermometer to the upper air. In the course of the afternoon we made a kite some six feet high, attached to it a self-registering thermometer, and after a number of trials succeeded in getting it up about five hundred feet, and in hauling it safely in again after it had been up over an hour. The thermometer had a wet bulb, and beside was protected from the direct rays of the sun; but it

registered only half a degree more of heat at its highest point than it had done in the pilot-house. The course the kite took showed no difference between the air currents aloft and aloft.

TABLE E.

Observations at Little Gull Island, Long Island Sound, August 10, 1881, commencing at 10:30 A. M. Dry Bulb Thermometer, 76°, Wet Bulb, 75°. Barometer, 29.40. Wind, W. by N., force 3, and steady throughout. Day clear and beautiful.

Number of Observation.	Time of Observation.	Distance from Little Gull Island in a direct line in statute miles.	Intensity of sound in a scale of ten.	Number of Observation.	Time of Observation.	Distance from Little Gull Island in a direct line in statute miles.	Intensity of sound in a scale of ten.
1	<i>h. m.</i> 10 36	1 $\frac{1}{8}$	10	7	10 59	2 $\frac{1}{8}$	2 to 3
2	10 40	0 $\frac{3}{8}$	10	8	11 07	2 $\frac{3}{8}$	2 to 3
3	10 44	0 $\frac{1}{2}$	5	9	11 29	2 $\frac{5}{8}$	2 to 3
4	10 45	0 $\frac{3}{4}$	2	10	11 45	5 $\frac{1}{8}$	2 to 3
5	10 49	0 $\frac{3}{4}$	4	11	11 52	5 $\frac{3}{8}$	2
6	10 53	1 $\frac{1}{4}$	3	12	12 02	6	2

The Light House Board has known from the first that aberrations in audibility might occur near any fog-signal. When the fog-trumpet was set up at Beaver Tail Point in 1856, the Naval Secretary of the Board, then Lieutenant, now Rear Admiral Jenkins, U. S. N., in company with Mr. Daboll, its inventor, found, in returning to Newport, that they lost the sound of the signal between Beaver Tail and Fort Adams, and recovered it again between the Fort and Newport, as did later observers, and that this failure to hear it did not result from any failure of the signal to operate.

The Board's publications show that Prof. Henry, its scientific adviser, had the subject for many years continuously under advisement, and that between 1865 and 1878, many experiments were made, and various reports on them were submitted to the Board, as to the use and value of its several kinds of fog-signals. In 1870 the Board directed General Duane, of the U. S. Engineers, then and still in its service, to make a series of experiments to ascertain the comparative value of its different signals. In his report the General said, speaking of the steam fog-signals on the coast of Maine:



* "There are six steam fog-whistles on the coast of Maine; there have been frequently heard at a distance of twenty miles, and as frequently cannot be heard at the distance of two miles, and this with no perceptible difference in the state of the atmosphere.

"The signal is often heard at a great distance in one direction, while in another it will be scarcely audible at the distance of a mile. This is not the effect of wind, as the signal is frequently heard much farther against the wind than with it; for example, the whistle on Cape Elizabeth can always be distinctly heard in Portland, a distance of nine miles, during a heavy northeast snow-storm the wind blowing a gale directly from Portland toward the whistle."

* * * * *

"The most perplexing difficulty, however, arises from the fact that the signal often appears to be surrounded by a belt, varying in radius from one to one and a half miles, from which the sound appears to be entirely absent. Thus, in moving directly from a station, the sound is audible for the distance of a mile, is then lost for about the same distance, after which it is again distinctly heard for a long time. This action is common to all ear-signals, and has been at times observed at all the stations, at one of which the signal is situated on a bare rock twenty miles from the main land, with no surrounding objects to affect the sound."

Prof. Henry, in considering the results of Gen. Duane's experiments, and his own, some of which were made in company with Sir Fred'k Arrow and Capt. Webb, H. B. M. Navy, both of the British Light-House Establishment, who were sent here to study and report on our fog-signal system, formulated these abnormal phenomena. He said they consisted of:

"1. The audibility of a sound at a distance and its inaudibility nearer the source of sound.

"2. The inaudibility of a sound at a given distance in one direction, while a lesser sound is heard at the same distance in another direction.

"3. The audibility at one time at a distance of several miles, while at another the sound cannot be heard at more than a fifth of the same distance.

"4. While the sound is generally heard further with the wind than against it, in some instances the reverse is the case.

"5. The sudden loss of a sound in passing from one locality to another in the same vicinity, the distance from the source of sound being the same." †

These experiments were not confined to our own shores. Dr. Tyndall, the well known English physicist, who stands in the same relation to the British Light-House Establishment that Prof. Henry did to our own, writes thus:

* Annual Rep't L. H. Board 1874, pp. 99-100.

† L. H. B. Annual Rep. 1875, page 106.

"With a view to the protection of life and property at sea, in the years 1873 and 1874, this subject received an exhaustive examination, observational and experimental. The investigation was conducted at the expense of the Government, and under the auspices of the Elder Brethren of the Trinity House [the governing body of the British Light-House Establishment.]

"The most conflicting results were at first obtained. On the 19th of May, 1873, the sound range was $3\frac{1}{3}$ miles; on the 20th it was $5\frac{1}{2}$ miles; on the 2d of June 6 miles; on the 3d more than 9 miles; on the 10th 9 miles; on the 25th 6 miles; on the 26th $9\frac{1}{4}$ miles; on the 1st of July $12\frac{3}{4}$ miles; on the 2d 4 miles, while on the 3d, with a clear, calm atmosphere and smooth sea, it was less than 3 miles."*

The officer who made the reports, as to the fog-signals at Beaver Tail and Little Gull, after the accidents to the steamers Rhode Island and Galatea heretofore mentioned, was the Assistant Inspector of the Third Light-House District, Lieut. Comd'r F. E. Chadwick, U. S. N.; and it was he who had charge of the Light-House steamer while the foregoing observations were being made, after Capt. George Brown, U. S. N., the Inspector—to whom I am indebted for many courtesies on this trip—was called elsewhere by other official duties. Mr. Chadwick brought to this work an unbiased mind, trained in the severest schools of scientific investigation. His object in all his experiments was simply to ascertain the exact truth for practical official purposes. He had not proposed, even to himself, to make any generalizations from his observations. But he kindly answered certain of my questions as to the opinions which had forced themselves upon him, and his answers are here set down for the consideration of those who use these fog-signals overmuch as a guide for their ships.

"It seems to me" he said "that navigators should understand that when attempting to pick up a fog-signal attention must be given to the direction of the wind, and that if they are to windward, (in a moderate breeze,) the chances are very largely against hearing it, unless close to; that there is nearly always a sector of about 120° to windward of the signal in which it either cannot be heard at all, or in which it is but faintly heard. Thus, with the wind E. S. E., so long as they are bearing from the signal between N. E. and South, there is a large chance that the signal will not be audible until it is very close.

"As they bring the signal to bear at right angles with the wind, the sound will almost certainly in the case of light wind increase, and it will soon assume its normal volume—being heard almost without fail in the leeward semicircle.

"Fog, to my mind, and so far as my experience goes, is not a factor of any consequence whatever in the question of sound. Signals may be heard at great dis-

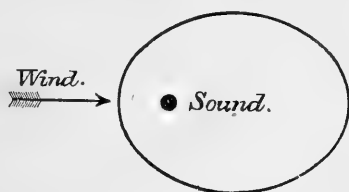
*Sound, by Tyndall, 3d Edition English, page 324.

tances through the densest fogs, which may be totally inaudible in the same directions and at the same distances in the clearest atmosphere. It is not meant by this last statement that the fog may assist the sound; as at another time the signal may be absolutely inaudible in a fog of like density, where it had before been clearly heard. That fog has no great effect can easily be understood when it is known, (as it certainly is known by observers,) that even snow does not deaden sound—there being no condition of the atmosphere so favorable for the far reaching of sound signals as is that of a heavy N. E. snow storm, due supposably to the homogeneity produced by the falling snow.

"It seems to be well established by numerous observations that on our own northern Atlantic coasts the best possible circumstances for hearing a fog-signal are in a northeast snow storm, and, so far as these observations have extended, they seem to point to the extraordinary conclusion that they are best heard with the observer to windward of the signal; and that in light winds the signal is best heard down the wind, or at right angles with the wind.

"The worst conditions for hearing sound seem to be found in the atmosphere of a clear, frosty morning on which a warm sun has risen and has been shining for two or three hours.

"The curve of audibility in a light or moderate breeze, in general, is similar to that plotted by Prof. Henry, as in the accompanying diagram.



"I think it is established that there are two great causes for these phenomena, non homogeneity of the atmosphere, and the movement of the wind; how this latter acts no one can say. The theory of retardation of the lower strata of the atmosphere near the earth's surface, as advanced by Prof. Stokes, of England,* seems good for moderate winds, but it hardly holds in cases where the siren is heard from eighteen to twenty miles to windward during N. E. gales."

While the mariner may usually expect to hear the sound of the average fog-signal normally as to force and place, he should be prepared for occasional aberrations in audition. It is impossible at this point in the investigations which are still in progress, to say when, where or how the phenomena will occur. But certain suggestions present themselves even now as worthy of consideration.

It seems that the mariner should, in order to pick up the sound of the fog-signal most quickly when approaching it from the wind-

*See Henry on Sound, p. 533; or, Sm. Rept., 1878, p. 533; or, L.-H. B. Rept. for 1875, p. 120. See Henry on Sound, p. 512, and Taylor in Am. Jour. Sci., 3d series, XI, p. 100, also, Rept. Brit. Assoc., XXIV, 2d part, p. 27.

ward, go aloft; and that, when approaching it from the leeward, the nearer he can get to the surface of the water the sooner he will hear the sound.

It also appears that there are some things the mariner should not do.

He should place no negative dependence on the fog-signal; that is, he should not assume that he is out of hearing distance because he fails to hear its sound.

He should not assume that, because he hears a fog-signal faintly, he is at a great distance from it.

Neither should he assume that he is near to it because he hears the sound plainly.

He should not assume that he has reached a given point on his course because he hears the fog-signal at the same intensity that he did when formerly at that point.

Neither should he assume that he has not reached this point because he fails to hear the fog-signal as loudly as before, or because he does not hear it at all.

He should not assume that the fog-signal has ceased sounding because he fails to hear it even when within easy earshot.

He should not assume that the aberrations of audibility which pertain to any one fog-signal pertain to any other fog-signal.

He should not expect to hear a fog-signal as well when the upper and lower currents of air run in different directions; that is when his upper sails fill and his lower sails flap; nor when his lower sails fill and his upper sails flap.

He should not expect to hear the fog-signal so well when between him and it is a swiftly flowing stream, especially when the tide and wind run in opposite directions.

He should not expect to hear it well during a time of electric disturbance.

He should not expect to hear a fog-signal well when the sound must reach him over land, as over a point or an island.

And, when there is a bluff behind the fog-signal, he should be prepared for irregular intervals in audition, such as might be produced could the sound ricochet from the trumpet, as a ball would from a cannon; that is, he might hear it at 2, 4, 6, 8 and 10 miles from the signal, and lose it at 1, 3, 5, 7, 9 and 11 miles distance, or at any other combination of distances, regular or irregular.

These deductions, some made, as previously mentioned, by several of the first physicists of the age, and some drawn from the original investigations here noted, are submitted for consideration rather than given as directions. They are assumed as good working hypotheses for use in further investigation. While it is claimed that they are correct as to the localities in which they were made, it seems proper to say that they have not been disproved by the practical mariners who have given them some personal consideration, and who have tried to carry them into general application. Hence these suggestions have been set down in the hope that others with greater knowledge and larger leisure may give the subject fuller attention, and work out further results.

If the law of these aberrations in audibility can be evolved and some method discovered for their correction, as the variations of the compass are corrected, then sound may be depended upon as a more definite and accurate aid to navigation. Until then, the mariner will do well when he does not get the expected sound of a fog-signal, to assume that he may not hear a warning that is faithfully given, and then to heave his lead, and resort to the other means used by the careful navigator to make sure of his position.

Mr. CLEVELAND ABBE remarked that it seemed to him if these anomalies were due to the refraction of sound in a vertical plane, then a few feet of increase in the altitude of the observer or of the signal itself, would make a great difference in the result. To this Mr. JOHNSON replied that the observations made on board the vessels were attended with the same results as to degree of audibility, whether the observer were stationed upon the mast, deck, or near the water line of the vessel.

Mr. WILLIAM B. TAYLOR said that the interesting observations presented by Mr. Johnson were in the main entirely corroborative of the results announced by our late President, Prof. Henry; and the anomalies noted furnished striking confirmation of the explanations

and generalizations reached by him, while they as strikingly discredited as incongruous the rival hypothesis of hygroscopic flocculence in the atmosphere as a notable occasion of acoustic disturbance. When we consider the wide areas over which fog-signals are designed to be conveyed—through which spaces the atmosphere can rarely be uniform, either in its temperature or its movements—we can readily understand that from these two prominent conditions of sound-refraction, acoustic rays are commonly propagated in quite sensibly curved or often serpentine directions; and that while these inequalities will sometimes favor audibility at given points, they will as often impair or defeat it. Moreover, these deformations of sound waves are not confined to vertical planes, since it has been shown that *lateral* refractions may exist, giving false impressions of direction as well as of distance.

As we have no means of either controlling or accurately determining these simultaneous differences of wind and temperature, we are forced to admit that the practical difficulties attending these anomalies of sound propagation are insoluble and incurable. But we must not hence abandon sound-signalling as either hopeless or inefficient, since it is the best—or rather the only—method at our disposal of giving warning and guidance to the befogged mariner.

Two partial alleviations of the recognized defects are suggested. The first is to place the siren or the steam whistle at considerable elevations, say on the top of skeleton towers, perhaps higher than those ordinarily employed as light-towers; at which points they could readily be operated from the ground. This would, in many cases, counteract the tendency to local acoustic shadows or bands of silence, though in other cases it would be quite ineffectual. The second expedient is, (if not too expensive,) to greatly multiply the number of such signals at available points about dangerous coasts or inlets, with proper distinctions to clearly specialize their indications, in order that the mariner failing to catch the sound from one direction, might have the probability of picking up the sound from a different azimuth. As these sound instruments may be operated at considerable distances from the engine, and even at practically inaccessible positions, on rocks or on buoys, *danger points* especially should be guarded by fog-signals, not necessarily of great power, but capable, at least, of covering the radius of actual insecurity.

Remarks were made by Mr. WILLIAM B. TAYLOR on the relation of fog and snow storms to audibility.

With regard to fog, Mr. TAYLOR said, we are not to conceive the sound vibrations as passing alternately through air and water, (as a ray of light does,) but taking into view the average wave-length of sound (several feet ordinarily) and the enormous number of water particles contained in that space, we must contemplate the whole mass as a homogeneous medium taking up the sound waves in the same manner, whether the air were perfectly dry, or were precipitating excessive moisture in the form of rain. In the absence of sensible wind, the air thus supersaturated with moisture would be practically very homogeneous, and thus generally well adapted to the normal transmission of sound.

A similar remark applies to falling snow, (when not accompanied with strong wind,) with the additional circumstance that, while the precipitation and congelation would tend to warm the upper regions of the air, any melting of the snow as it fell would cool the lower region. This condition of relative warmth above and cold below is favorable to the conveyance of sound to a distance—as first pointed out by Prof. Osborn Reynolds, of Manchester,—by reason of the expanding spherical wave-front being slightly more accelerated above than below, (in accordance with well known principles,) and thus causing the horizontal or slightly rising sheets of sound to be dished downward.

The next communication was by Mr. WILLIAM HARKNESS on the relative accuracy of different methods of determining the solar parallax.

This paper is published in full in the *American Journal of Science* for November, 1881, No. 131, vol. 22, pp. 375-394.

205TH MEETING.

NOVEMBER 5, 1881.

The President in the Chair.

Forty-three members present.

MR. J. C. WELLING presented the following communication on

ANOMALIES OF SOUND SIGNALS.

In the year 1865 Prof. Henry, while making some observations on the intensity of sounds, discovered that a sound moving against the wind, and which was inaudible to the ear of an observer on the

deck of a vessel, might sometimes be regained by ascending to the mast-head; that is, sound is sometimes more readily conveyed by the upper current of the air than by the lower.

This fact, with other corroborative facts, did not, he says, reveal its full significance to him until he was able to interpret it by the aid of the hypothesis of Prof. Stokes, (Transactions of the British Scientific Association for 1867, Vol. 24,) according to which there is—when the wind blows—a difference of velocities between the upper and the lower strata of the atmosphere, resulting from the retardation of the lower stratum by friction with the ground. This unequal movement of the atmosphere disturbs the spherical form of the sound waves, and tends to make them somewhat of the form of an ellipsoid, the section of which by a vertical diametral plane, parallel to the direction of the wind, is an ellipse, meeting the ground at an obtuse angle on the side towards which the wind is blowing, and at an acute angle on the opposite side. But as sound moves in a direction perpendicular to the front of the sound waves, it follows that sounds moving with a favorable wind tend to be tilted downwards toward the ground; and sounds moving against an opposing wind tend to be tilted upward until, finally, they pass above the head of a listener standing on the ground.

The effect of different elevations on the audibility of the same sound has been brought within the sphere of scientific experiment. In some experiments made by Prof. Reynolds in 1874, on “a flat meadow,” by the aid of an electrical bell, placed one foot from the ground, it was found that elevation affected the range of sound against the wind “in a much more marked manner than at right angles.” He adds: “Over the grass no sound could be heard with the head on the ground at twenty yards from the bell, and at thirty yards it was lost with the head three feet from the ground, and its full intensity was lost when standing erect at thirty yards. At seventy yards, when standing erect, the sound was lost at long intervals, and was only faintly heard even then; but it became continuous again when the ear was raised nine feet from the ground, and it reached its full intensity at an elevation of twelve feet.”*

In some experiments made by Prof. Henry, in 1875, he found that while sound moving at right angles to the wind could not be heard as far as sound moving with the wind, yet it was equally true

* London, Ed., and Dub. Ph. Mag. for 1875, Vol. 50.

of sounds moving against the wind and at right angles to the wind, that they could both be better heard on the top of a high tower than on the surface of the ground.*

Baron Humboldt, in observations made on the intensity of sounds at the Falls of the Orinoco, remarked their greater audibility by night than by day, and referred their comparative weakness by day to the effect of atmospheric disturbances arising from ascending currents of rarified air and descending currents of heavier air, which broke up the homogeneity of the atmosphere, and thereby obstructed the transmission of sound. It is a necessary complement of this hypothesis that sound which fails to be transmitted through the atmosphere, because of "the reflections which it endures at the limiting surfaces of the rarer and the denser air," is liable to be returned to the hearer in the shape of aerial echoes rebounding from the acoustic cloud which the primary sound is not able to pierce; and hence the logical place assigned to echoes by Dr. Tyndall, when, adopting and applying the Humboldt hypothesis, he says that "rightly interpreted and followed out, these aerial echoes lead to a solution which penetrates and reconciles the phenomena from beginning to end." "On this point," he says, "I would stake the issue of the whole inquiry. * * * The echoes afford the easiest access to the core of this question."†

The conflicting hypotheses of Humboldt and Stokes, as respectively applied by Tyndall and Henry in interpreting the abnormal phenomena of sound, are here cited as prefatory to some much older observations made under the same head by Dr. W. Derham, in his elaborate paper entitled "Experiments and Observations on the *Motion of Sound*, and other things pertaining thereto," as read before the Royal Society in 1708. This paper, written in Latin, is the report of a systematic inquiry into phenomena pertaining to the velocity and motion of sounds, and treats only incidentally on the intensity of sounds; but, nevertheless, it contains some interesting statements under this latter head.‡

The subject of echoes is the first which engages the writer's attention. He says that echoes produced by sound-reflecting objects situated near a sounding body may sometimes be heard through many

* Rep. of Light-House Board, 1875, p. 119.

† "Sound," p. xxiv.

‡ Phil. Trans. of Royal Society, Jan. and Feb., 1708.

miles, as well as the primary sound, or even better than the latter. He observes that echoes produced by the firing of cannon on the Thames river, between Deptford and Cuckold's Point, came to his ears in a multiple form, repeated five or six times, and the terminal crash of the echo was the loudest. This last feature was observed even when the multiple sounds were nine or ten in number. To this he adds: "When I have heard the crashes of heavy artillery, especially in a still and clear atmosphere, I have often observed that a *murmur* high in the air preceded the report. And in thin fog I have often heard the sound of cannon running in the air, high above my head, through many miles, so that this murmur has lasted fifteen seconds. This continuous murmur, in my opinion, comes from particles of vapor suspended in the atmosphere which resist the course of the sound waves, and reverberate them back to the ears of the observer after the manner of undefined echoes.*

Mr. Richard Townley, an intelligent observer, having written to Dr. Derham, in a letter from Rome, that "sounds are rarely heard as far at Rome as in England and in other northern regions, and having cited in support of this statement some observations drawn from the firing of cannon in the castle of St. Angelo, Dr. Derham caused an enquiry on this point to be made in Italy, under the auspices of the British Minister at Florence. The enquiry was conducted by Joseph Averani, a Professor in the University of Pisa. Guns were fired at Florence, and observers were stationed at different points in Leghorn and its vicinity to mark the effect of the reports. The observers stationed in the Light-House and the Marzocco tower, in the lower part of the city, heard no reports, but observers stationed on an old fortress in the upper part of the city, and other observers placed on Monte Rotondo, about five miles from Leghorn in the direction of Mount Nero, (and, therefore, more in the direction of the wind which was blowing across the path of the sound,) were able to hear the reports.

Another series of experiments was made on water, by firing cannon at Leghorn, and stationing observers at Porto Ferrajo in the Island of Elba, a distance of about sixty miles. In this case the reports were better heard in still air than when the wind was either favorable or unfavorable, and were not heard at all points equally well, but only at those which were a little the more elevated.†

* Derham, p. 10. † *Ibid.*, pp. 18, 19, 20.

As to the result of these observations, it was easy for Dr. Derham to conclude that sounds are heard as far in Italy as in England, when the conditions of the atmosphere are the same; and these experiments are here cited only for the light they shed on the comparative antiquity of the observation that elevation has an important bearing on the audibility of sounds.

As to the causes which really affect the intensity of sounds, Dr. Derham seems to have had a very obscure and imperfect notion. His observations under this head are mainly a bundle of contradictions, and the causes of these variations he prudently leaves to be investigated by others, seeing, as he says, "that it equally exceeds the grasp of his mind to discover them, and to assign what may be the proper medium or vehicle of sound." He does not, however, fall into the error of measuring the acoustic transparency of the atmosphere by its optic transparency, for he says that the clearest day he can remember, when wind and everything else seemed to concur in promoting the force and velocity of sound, was a day when he could not hear the firing of cannon at a distance easily penetrated by their reports on former occasions. The effect of clear or foggy air on sound, he says, is very uncertain, but as to *thick fogs* and snow, he affirms that they are certainly powerful dampers of sound, an observation now abundantly proved to be erroneous.

From some observations made by Gen. Duane, at Portland, Maine, in 1871, it appears that the fog-signal at that point is often surrounded by a belt of silence, varying from one to one and a half miles in radius.

From some observations made by Prony, Mathieus, and Arago, at Villejuif, and by Humboldt, Bouvard, and Gay-Lussac, at Monthéry, in France, the two towns being 11.6 miles from each other, it was noticed that while every report of the cannon fired at Monthéry was heard with the greatest distinctness, nearly every report from Villejuif failed to reach Monthéry. The air at the time was calm, with a slight movement of wind from Villejuif toward Monthéry, or "against the direction in which the sound was best heard." These observations were made in 1822.

In 1872, Prof. Henry observed the same non-reciprocity of sound in approaching the Whitehead fog-signal on the coast of Maine. At a distance of six miles the signal was heard; at a distance of three miles from the shore the sound of the signal was lost, and was

not regained until the vessel approached within a quarter of a mile of the station. During all this time of silence the sound of the steamer's whistle was distinctly heard at the Whitehead station; that is, a lesser sound was heard from the steamer to the station, "while a sound of greater volume was unheard in the opposite direction." The wind at the time was blowing in favor of the steamer's whistle, and against the fog-signal.*

In a paper presented to the Royal Society in 1874, Prof. Reynolds showed that the form of the sound-wave is liable to flexure from changes in the temperature of the atmosphere as well as from the unequal motion of wind.†

These abnormal phenomena of sound, considered in connection with the hypothesis of Prof. Stokes, as enlarged and applied by Prof. Henry, may be reduced into the following generalizations which, if accurate in point of logical form, and true in point of the facts to which they are applied, may be stated under the guise of aphorisms, as follows:

1. "Where the condition of the air is nearest that of a calm, the larger will be the curve of audition, and the nearer will the shape of the curve approach to a circle, of which the point of origin of the sound, or the point of perception will be the centre." [This aphorism is stated abstractly from any consideration of temperature refraction which, so far as it exists, will always tend to modify the shape of the curve of audition.]‡

2. Apart from all consideration of temperature refraction, a sound will be heard furthest in the direction of a gentle wind, because the portion of the sound-wave thrown down from above, in this case, is re-enforced by the sound reflected from the surface, and will thus more than compensate for the loss by friction.||

3. Other things being equal, the area of audition will be proportionally diminished in the case of sounds moving against winds more or less strong, because the sonorous waves will be refracted above the ears of the observer. (Stokes, Henry and Reynolds.)

* Rep. Light-House Board, 1874, p. 108.

† London, Ed., and Dublin Phil. Mag. for 1875, Vol. 50, p. 52.

‡ Light-House Report for 1875, p. 125.

|| *Ibidem.* Cf., Tyndall's Sound, p. 311. Cf., Reynolds in Lon., Ed., and Dub. Ph. Mag. for 1875, Vol. 50, pp. 63, 68.

4. The area of audition will be diminished in the case of a sound moving with an overstrong favoring wind, because the sound-waves in this case will be so rapidly and strongly thrown down to the ground that the intensity of the sound will suffer more diminution from absorption and friction than can be supplied by the upward reflection of the sound rays conspiring with the gradual downward flexure of the sound-waves, as in the case of a gentle favoring wind.*

5. Sounds moving *against* a gentle wind will, *cæteris paribus*, be heard further than similar sounds moving *with* an overstrong favoring wind, for reasons already implied, because the downward flexure of the sound-waves, being excessive in the latter case, tends to extinguish the conditions of audibility more rapidly than is done by the slight upward refraction in the former case.

6. When sounds moving against the wind are heard further than similar sounds moving with a wind of equal strength, it is because of a dominant upper wind blowing at the time in a direction opposite to that at the surface.†

7. A sound moving against the wind, and so refracted as in the end to be thrown above the head of the observer will, at the point of its elevation, leave an acoustic shadow. But this acoustic shadow, at a still further stage, may be filled in by the lateral spread of the sound-waves, or may be extinguished by the downward flexure of the sound waves, resulting from an upper current of wind moving in an opposite direction to that at the surface, or resulting in a less degree from an upper stratum of still air. Under these circumstances, there will be areas of silence enclosed within areas of audition.‡

8. As sounds may be refracted either by wind, or by changing temperatures, or by both combined, it follows that, under many circumstances, a sound lost at one elevation may be regained at a higher elevation.||

9. As sounds moving against the wind are liable to become inaudible (by being tilted over the head of the observer) even before

* Light-House Report, 1875, p. 125.

† Light-House Report for 1877: Experiments on Sound, p. 13.

‡ Experiments on Sound, 1877, p. 8.

|| Henry and Reynolds. Cf., Delaroche, Ann. de Chim., 1816, Tome I, p. 180.

their intensity has been extinguished, we may find in this fact an explanation of the statement made by Reynolds, that "on all occasions the effect of wind seems to be rather against distance than distinctness."*

10. As sounds may be inaudible at certain distances and elevations without being wholly extinguished, it follows that the comparative inaudibility of sounds at different times cannot always be cited as an evidence of their relative intensities. The comparative inaudibility may be a function of variable refraction rather than of variable intensity. Hence the law of inverse squares, though perfectly true in its theoretical application to the measurement of the intensity of all sounds, cannot always be legitimately used to calculate backwards from the audibility of a sound, as empirically ascertained at a given point and elevation, to its relative intensity as previously heard at the same point and elevation.

11. The hypothesis of Stokes, as applied by Henry, does not exclude the hypothesis of Humboldt, but reduces the latter to a very subordinate and inappreciable place in interpreting the abnormal phenomena of sound.

12. The hypothesis of Stokes, as applied by Henry, does not exclude the reasoning or the experimental proofs by which Prof. Reynolds demonstrates that differences in temperature exert a refracting power in sound, but finds in that refraction an influence which may sometimes accelerate and sometimes retard the refraction produced by wind.†

The next communication was by Mr. C. H. KOYL, Fellow of the Johns Hopkins University, on

THE STORAGE OF ELECTRIC ENERGY.

After discussing the subject from an historical point of view, concluding with a description of the improved form of secondary battery lately invented by M. Faure, the author proceeded to state the

* Lon., Ed., and Dub. Ph. Mag. for 1875, Vol. 50, p. 63.

† Rep. Light-House Board 1875, p. 125, cf. Reynolds; Lon., Ed., and Dub. Ph. Mag. for 1875, Vol. 50, p. 71.

results of some investigations carried on independently in this country by Mr. J. A. Maloney and Mr. Franz Burger, of Washington, and afterward by himself in connection with them.

Mr. Maloney and Mr. Burger had been aiming to interpose in the circuit of the electric lamp a reservoir of energy which should perform the same function for the electric lamp that a gasometer did for a gas-burner, viz., prevent its flickering by keeping a constant or nearly constant potential on the main line, even though the current from the source should be irregular.

A long course of experiment convinced them that plates of lead immersed in dilute sulphuric acid form a combination preferable to any other for giving return currents when once these plates have been made part of an electric circuit. They noticed what they believed to be an oxide of lead formed on one plate, and since the thicker the coating of oxide the greater the effect, they began to regard this layer as a sort of sponge which, in some way, held the electricity, and they concluded to increase the holding capacity of the cell by increasing the thickness of the sponge. Oxide of lead was accordingly purchased and painted on, with results which were surprising. The storage of electricity in large quantity was effected. This was of course independent and without any knowledge of Mr. Faure's work in Europe, but the chief merit of their inquiry lies in the rapidity with which they grasped the idea of *mechanically* increasing the sponge-like coating.

While they were testing the capabilities of the battery and were still endeavoring to improve it, the announcement was made of Mr. Faure's similar inventions. Soon after the battery was submitted for experiment to three members of this Society, and subsequently the co-operation of the author was invited for further study of the subject.

On examining the plates during their summer investigations they found reason for believing that the published theory of the action of the cell was but partly correct; for after the plates had been charged the changes of color and, therefore, of chemical constitution, upon which the return current was supposed to depend, were found, in general, not to take place until the return current had been passing for some time. If so, in something else than chemical combination must lie the storage capacity of these cells. The conclusion arrived at from their investigations was that the change of

red-lead into peroxide upon one plate and into spongy lead upon the other required only a small part of the oxygen and hydrogen liberated by the primary current and that the remainder was mechanically held in the coatings.

Several minor considerations support this view, and the principal experiments upon which the proof should rest, viz., the liberation of the gas in a vacuum or by slight application of heat in general succeed. Some anomalies, however, are presented which require further study, but which the author hopes soon to reconcile with the theory of mechanical storing.

A discussion followed, in which several members participated.

206TH MEETING.

NOVEMBER 17, 1881.

The President in the chair.

Thirty-eight members present.

The communication for the evening was by Mr. G. K. GILBERT

ON BAROMETRIC HYPSONOMETRY.

This communication was reserved by the author, and his views and investigations in connection with this subject will be found in a paper contributed by him to the Second Annual Report of the Director of the United States Geological Survey.

A brief discussion ensued, and one or two points were questioned

207TH MEETING.

DECEMBER 3, 1881.

The President in the chair.

Seventy-six members and visitors present.

Under the rules this meeting, being the next preceding the annual meeting, was set apart for the delivery of the address of the

retiring President of the Society. Calling Vice-President Hilgard to the chair, the President of the Society, Mr. J. J. WOODWARD, then read the following address:

MODERN PHILOSOPHICAL CONCEPTIONS OF LIFE.

I address you this evening in accordance with the fifth of the new Standing Rules for the government of the Philosophical Society of Washington, adopted in January last, which directs that the stated meeting next preceding the annual meeting for the election of officers shall be set apart for the delivery of the President's Annual Address. By the rules adopted at the first organization of the society the President's address was directed to be delivered on the evening of the annual meeting after the election of officers had taken place. It was found, however, that the elections always occupied the whole meeting, so that the address was necessarily postponed until after the term of office for which the President was elected had expired. During the presidency of the illustrious Professor Henry, who by common consent was re-elected annually, the inconvenience of this arrangement was not felt. But I understood the general sense of the Society last year to be that an annual change of President is desirable, and that this standing rule was adopted in view of that feeling, in order to give the retiring President a convenient opportunity for the delivery of his address before his term of office expires.

For my own part I was last year, and am now, thoroughly convinced of the desirability of electing a new President annually in a society like ours. I think on the one hand that it is a measure well calculated to increase the interest taken in the society by its members, and on the other hand that the preparation of a formal annual address would be too great a tax upon the time of a President re-elected from year to year. I think, too, that there is much propriety in a suggestion which I heard expressed in many quarters last year, that our President should be selected alternately, from what may be called for convenience, the Physical and Biological sides of the society, so that having been myself elected as in some sort a representative of the Biological side, it is my hope that you will at the next meeting elect as my successor a representative of the Physical side. With this brief explanation I will proceed at

once to the consideration of the subject I have selected for the present occasion.

I propose to invite your attention this evening to some thoughts on the *Modern Philosophical Conceptions of Life*. The theme is so large that it would be idle to attempt its systematic treatment in the course of a single evening; nor do I pretend to be in possession of any satisfactory solution of this ancient question, of which I might offer you an abstract or outline, pending the fuller presentation of my results elsewhere. Yet I have ventured to hope that a discussion of some of the considerations involved, and a brief statement of certain views that I have been led to entertain, would not be without interest, and perhaps might prove of actual service, especially to those of you who are engaged in biological pursuits.

Undoubtedly the conception of life most popular at the present time is that which assumes all the phenomena of living beings to be the necessary results of the chemical and physical forces of the universe, and claims, or intimates, that wherever this has not yet been proven to be the case the evidence will hereafter be forthcoming. This doctrine, which may conveniently be designated the chemico-physical hypothesis of life, has readily found its way from the speculative writings of philosophers to the rostrums of some of our teachers of chemistry and physics who boldly declare, in their class-lectures and public addresses, that the forces at work in the inorganic world are fully adequate to explain all the phenomena of living beings, and prophesy that the time is soon coming "when the last vestige of the vital principle as an independent entity shall disappear from the terminology of science."¹

Now, most of these gentlemen are not embarrassed by any very definite or detailed knowledge of the physiological and pathological phenomena which a tenable theory of life must be competent to explain, while they do know, or at least ought to know, a great deal of chemistry and physics; the confidence with which they maintain their creed is therefore readily understood. Much more surprising is it to find the same doctrine embraced by numerous zoologists, physiologists, nay, even pathologists, among them men who cannot for a moment be supposed to be unacquainted with the phenomena to be explained, and of whose abilities and reasoning powers it is impossible for me to think or speak otherwise than respectfully. Yet I cannot but believe that they have adopted the chemico-physical hypothesis, not so much because they are really

satisfied with it as a scientific explanation of all the phenomena, as because they are unduly biased in its favor by the utterances of the great philosopher who has done, as I think we will all agree, such good service to biological science by elaborating and popularizing the doctrine of evolution.

It is only natural that such a bias should exist. The discussion of the nature of life—in the case of man at least—has always, and not unreasonably, been conjoined with the discussion of the nature of the soul, and the philosophers who have won highest repute in the latter discussion, have always been willing enough to offer solutions of the life-problem, and have never had any difficulty in finding followers even among those whose special lines of investigation might be supposed to impose upon them the duty of independent inquiry into the meaning of life.

Just as it was in the old time, with regard to this matter, so it is now. When Galen undertakes to discuss the complex phenomena of the Psyche, as manifested by the human species, he openly and continually confesses the extent to which he relies upon the authority of Plato; and when the dicta of the master are such as to require a special effort of faith on the part of the disciple, he honestly exclaims "Plato indeed appears to be persuaded of this, as for me, whether it be so or not, I am unable to dispute the question with him."²

In like manner, did they venture to be as frank as Galen was, most of the modern biologists who have adopted the chemico-physical theory of life would, I presume, confess "as to this matter our opinions are derived from Mr. Herbert Spencer's *Principles of Biology*—what are we that we should venture to dispute as to questions like these with him."

Nevertheless in striking contrast to this chemico-physical hypothesis of life, which is to be regarded as the fashionable faith of the hour, there still survives in many quarters, and especially among physicians, a disposition to regard indiscriminately almost all the phenomena of living beings as peculiar manifestations of a vital principle. So strong, indeed, is the faith of some of these modern vitalists, that they seem to shut their eyes to the evidence already in our possession as to the actual participation of known chemical and physical forces in the operations going on within living bodies, and appear almost to resent the willing aid that chemistry and physics afford to the physiological investigator of the present day.

Nay, further than this, in the inevitable reaction that is beginning to make itself felt against the avowed revival of the materialism of Epicurus and Lucretius—for we all know now that the chemico-physical hypothesis of life is not a new induction of modern science, but an ancient Greek speculation reappearing in modern petticoats—that other Greek speculation of the threefold Psyche, the doctrine taught by Plato and Aristotle, and which Galen accepted on their authority, the doctrine of a vegetable, an animal, and a rational soul, a human trinity coexisting in every human being, is once more rehabilitated and finding followers—likely, indeed, as I think, to obtain more followers than perhaps any of you yet suppose. And these followers are by no means confined to metaphysicians or churchmen, they can be found also already among the biologists. It is an English biologist of good repute, and of no mean abilities, who takes occasion, in a technical biological work published this very year, to express his belief that the Greek conception of the threefold Psyche “appears to be justified by the light of the science of our own day.”³

For myself I must confess at once that I am quite unable to join either of these opposing camps as a partizan. I cannot accept the more strictly vitalistic views, because I am compelled continually to recognize the operation of purely chemical and physical forces in living beings. On the other hand, there are whole groups of phenomena characteristic of living beings, and peculiar to them, for which the chemico-physical hypothesis offers no intelligible explanation.

From this point of view the various processes and functions of living beings may indeed be divided into two classes, of which the first may be regarded with more or less certainty as the special results, under special conditions, of the very same forces that operate in the inorganic world; while the second, to which alone I would apply the term vital, are not merely in every respect peculiar to living beings, and hitherto utterly inexplicable by the laws of chemistry and physics, but are so different in character from the phenomena of the inorganic world that it does not seem rational to attempt to explain them by these laws.

Let me refer briefly to the processes and functions belonging to the first class. Here I place all those more strictly chemical processes by which, within the very substance of vegetable protoplasm, inorganic elements are combined into organic matter,

as well as those which produce all the various subsequent transformations, whether in plants or animals, of the organic matter thus prepared. This general conception includes of course, in the case of the higher animals, all the chemical phases of the processes of digestion, assimilation and tissue-metamorphosis or metabolism, including secretion and excretion; in the case of the lower animals and plants, so much of these several functions as belongs to each species.

Now please to understand that when I say I recognize all the chemical phases of these processes to be the results of the ordinary chemical laws, I do not entertain any mental reservation with regard to the unrestricted application of these laws. I cannot for a moment agree with those physiologists who have imagined the vital principle to thwart, or interfere with, or counteract these laws in any way. I know, indeed, that we are far from being as thoroughly acquainted, as we may by and by hope to be, with the chemical phenomena of living beings; that many of the questions are very difficult, so that as yet, with all our labor, we have obtained but partial or even contradictory results; but I find in this only a reason for further investigation—no logical difficulty of a radical kind. In a general way I recognize that the matter of which living beings are composed is built up of elementary substances belonging to the inorganic world, and that it consists of atoms possessed of the very same properties, and obedient to the very same laws as like atoms in inorganic bodies. Yet I confess I find in all this no reason for denying the existence of a vital principle; only I do not figure this principle in my mind as a hostile power interfering in any way with the chemical tendencies of the atoms present; I liken its operations rather to those of the chemist in his laboratory who obtains the results he needs only on the condition of most rigid obedience to chemical laws.

Intimately associated with some of the chemical processes just enumerated are those chemical processes of respiration, in which the chemical affinities of the oxygen of the atmosphere are directly or indirectly the means of promoting tissue metamorphosis, as well as of reducing at once to simpler forms some portion of the various complex substances derived from the food. These chemical processes are undoubtedly the chief original sources of the heat and mechanical power manifested by animals. Of course they receive heat also from without by conduction and radiation; but this is a

small matter to the heat generated within them; of course, too, mechanical power is continually transformed into heat within the body of animals, but this neither increases nor diminishes the total amount of energy liberated.

I yield my hearty assent to that modern scientific induction⁴ which sees in the potential energy of the complex chemical compounds supplied to animals by their food, the essential source of all the actual energy of the body, whether manifested in the form of heat or work. In a general way the reduction of these complex chemical compounds by oxidation into the much simpler ones, urea, carbon dioxide, and water, is the means by which potential is converted into actual energy. In the case of plants, too, the source of any little heat that may be developed under special conditions, and of such sluggish motions as actually occur, is doubtless to be found in the reduction to simpler combinations by oxidation of a part of the organic matter already formed. The chief function of the vegetable world, however, is to build up, by means of the solar energy, those complex and unstable organic compounds that supply the animal world with food. Nevertheless, while I yield my hearty assent to this generalization, and freely admit that it is more than a mere deduction from the general doctrine of the conservation of energy—that in fact it affords the most satisfactory explanation yet suggested for a large number of observed phenomena—it is my duty to caution you against the erroneous supposition that any one has ever yet succeeded in affording a rigorous demonstration of the truth of the generalization by an adequate series of actual experiments.

Various attempts have, indeed, been made of late years to determine experimentally both for animals and for man, the potential energy contained in the food of a given period, and the actual energy liberated during the same time in the form of heat and work. I think, however, that all practical physiologists who have looked into the question will agree with me that the numerical results hitherto obtained must be received with the utmost caution.⁵ Difficulties exist on both sides of the problem. It is comparatively easy, no doubt, to obtain a close approximation to the quantity and composition of the food; but to represent numerically what becomes of it in the body, to deduct correctly what passes through unchanged, and ascertain with reasonable accuracy the amount of carbon dioxide, water, and urea, into which the rest is transformed;

these are questions which have taxed the utmost resources of investigators, and as to which our knowledge is yet in its infancy.

On the other hand, the direct measurement of the resulting heat and work has hitherto proved still less satisfactory. It would seem to be a very simple thing to place an animal in a calorimeter, and measure the heat-units evolved in a given time, as Lavoisier and Laplace attempted to do in the latter part of the last century, and we have been told that "Lavoisier's guinea-pig placed in the calorimeter gave as accurate a return for the energy it had absorbed in its food as any thermic engine would have done."⁶ But this assertion is not supported by the results of actual experiment. We know now that many precautions, unknown to Lavoisier, must be taken to secure any approach to accuracy in calorimetric experiments with animals, and just as the method is being brought to something like perfection by arranging for the respiratory process and its influence on the results, and by other necessary modifications of the primitive rude attempts,⁷ doubts are beginning to arise as to whether after all the conditions in which the animal is placed in the calorimeter are not so far abnormal as seriously to vitiate the results;⁸ so that in fact the most approved numerical expressions of the heat-production of the body to be found in the books are based rather upon calculation of the amount that ought to be produced by the oxidation of an estimated quantity of food than upon actual calorimetric observations.

Nor do we find it any easier when we attempt the actual measurement of the amount of work produced by an animal from a given amount of food. Indeed, in attempting to formulate an equation between the potential energy of the food and the actual amount of heat and work in any given case, we are met with the special difficulty that the animal does not evolve less heat because it is doing work than it does when it is at rest; on the contrary, it actually evolves more heat, consuming for the purpose more food than usual—or if this is not forthcoming, consuming a part of its own reserve of adipose tissue—so that from this source fresh complications of the problem arise.

The labor and ingenuity with which all these difficulties have been encountered is certainly worthy of the highest praise, and I willingly admit the probably approximate truth of the figures generally in use, say $2\frac{1}{2}$ to $2\frac{3}{4}$ million gramme-degrees as the daily average heat-production of an adult man, and 150,000 to 200,000

metre-killogrammes as his capacity for daily mechanical work.⁹ Nevertheless these figures are after all only probable approximations, and there still exists, with regard to these questions, a large and inviting field for the application of chemical and physical methods to physiological research.

All the mechanical work done by living beings is effected by means of certain contractions of their soft tissues. The movements of the *amœba*, so often described of late years, may be taken as the type of the simplest form of these contractions. Similar movements occur, with more or less activity, in the protoplasm of all young cells, and in the higher animals are strikingly illustrated by the movements of the white corpuscles of the blood and the wandering cells of the connective tissue. In the lowest animal forms these simple *amœboid* movements of the protoplasm are the only movements, but in the higher forms, besides these, certain special contractile tissues make their appearance, by which the chief part of the mechanical work done is effected; these are the striated and unstriated muscular fibres.

On account of the extreme minuteness of the little protoplasmic bodies in which the *amœboid* movements are manifested, the investigation of the mechanical means by which these movements are effected has not as yet been attempted, although a great mass of details have been accumulated by actual observation with regard to the phenomena themselves and the conditions under which they occur. Very little more has been done with regard to the contractions of the unstriated muscular fibres. The striated muscles, however, have been made the subject of a host of researches, and I suppose the conclusions to which we may ultimately be led by these can be regarded, with but little reservation, as applicable to the function of the unstriated muscles, and also to the simpler *amœboid* protoplasmic contractions.

Yet, notwithstanding the vast amount of experimental labor and speculative ingenuity that has been lavished, since the time of Haller, upon the question of the contraction of the striated muscle, it must be confessed in the honest language of Hermann,¹⁰ that the problem still mocks our best endeavors. For myself, I am unwilling to believe that the phenomena of muscular contraction, or indeed, of any of the varieties of protoplasmic contraction by which animals effect mechanical work, will not by and by be fully and satisfactorily explained on chemico-physical principles. I cannot for a

moment give my adherence to the dogmatism of those modern vitalists who insist that the contractions of a muscle, or of an amoeba, are essentially vital phenomena; for this would be to claim that life can create force. But it would be folly to shut our eyes to the circumstance that no chemico-physical explanation of muscular contraction yet offered has been so convincingly supported by facts as to command the universal assent of competent physiologists.

Of the various hypotheses devised to explain muscular contraction, those which regard the phenomena as in some way resulting from electrical disturbances have long enjoyed great popularity. Such of these hypotheses as still survive are based upon the electrical manifestations actually observed in living muscles. It has been pretty generally accepted in accordance with the observations of Du Bois-Reymond, whose brilliant series of experiments in animal electricity¹¹ is deservedly renowned, that even quiescent living muscles are in a state of electrical tension. If, for example, a muscle composed of parallel longitudinal fibres, be exposed with suitable precautions, and divided near each extremity by a transverse incision, the surface of the muscle will be found to be positive to the cut ends, and if one of a pair of non-polarizable electrodes, connected with a suitable galvanometer, is placed in contact with the surface of the muscle and the other in contact with one of the cut ends, the existence of a current is made manifest. The conditions are, moreover, such that while the maximum effect is produced when the equator of the surface is connected with the centre of one of the cut ends; more or less current will also be manifested whenever any two points of the surface are thus connected with the galvanometer, provided they are not equidistant from the equator. In such cases the point most distant from the equator is always negative. The electro-motive force of this natural current of the quiescent muscle varies greatly, but has been found by Du Bois-Reymond to amount sometimes to as much as .08 Daniell in one of the thigh muscles of the frog.¹² In muscles of different form, or cut differently from what has just been described, the currents are somewhat differently arranged, but the example just given must suffice for my present purpose.

In accordance with the observations of the same investigator, it is claimed that during a muscular contraction the electrical tension diminishes, the normal muscle-current experiences a negative variation, and this occurs in such a way, that as the wave of actual

contraction moves along the muscle, which it does, according to the observations of Bernstein and Hermann,¹³ with a velocity of about 3 metres per second, it is preceded by a wave of negative variation. This negative variation is indeed so trifling, if the muscle contracts but once, that it is difficult to observe it; but when the contractions succeed each other with great rapidity, as in artificially produced tetanus, it may become sufficient to neutralize completely the deflection of the galvanometer due to the current of the quiescent muscle.

But the belief that the electrical currents, shown to exist in the quiescent muscles in these experiments, exist also in uninjured animals has not remained unchallenged. Since 1867 it has been attacked especially by Hermann,¹⁴ who has endeavored to show that these currents are produced only under the special conditions of the experiments, and that there are in reality no natural muscle-currents at all. It was well known that the currents observed in the experiments varied greatly under different circumstances, and it seemed a significant fact that they should be most intense when the muscle was removed from the body and had both ends cut off. If the muscle was removed with its tendinous extremities still attached, the current was usually found to be very feeble, or entirely absent, until the ends were well washed in salt and water, or dipped in acid. Du Bois-Reymond had explained this by supposing the natural ends of the muscle to be protected by what he called a *parelectronic* layer of positive elements that must be removed before the natural current could be made manifest. On the other hand, Hermann has endeavored to show that the parts injured by the knife, or acted on by the salt or acid, enter at once into the well-known condition of *rigor mortis*, and only become negative to the still living portions of the muscle in consequence of this change. That electrical disturbances actually occur in contracting muscles he admits, but endeavors to show that they are due simply to the fact that the changes preceding contraction make the affected part of the muscle negative to every part less modified or wholly unaltered. Hence, if an uninjured muscle be caused, under proper precautions, to contract simultaneously in all its parts, it will be found that the contraction is wholly unaccompanied by any muscle-current.¹⁵

Observations that appear to support these views of Hermann have been brought forward by Englemann.¹⁶ On the other hand

Du Bois-Reymond has defended his views with vigor, and sharply criticised, of course, the labors and logic of his assailant.¹⁷ I need not at present express any opinion as to the merits of this voluminous controversy. It is enough for my purpose to indicate the questions at issue as sufficiently important and uncertain to be well worthy of independent experimental criticism.

Suppose, however, this criticism should result in showing that Hermann is wholly in the wrong, and that the muscle-currents observed by Du Bois-Reymond really exist in healthy muscles. How, then, shall these currents explain the phenomena of muscular contraction? I presume that no physiologist of the present day is misled by the superficial comparison, which Mayer and Amici were led by their microscopical studies of the muscles of insects to make between the striated muscular fibre and a Voltaic pile.¹⁸ But the molecular theory by which Du Bois-Reymond has endeavored to explain his natural muscle-currents and their negative variation would appear to open up an inexhaustible mine of speculative possibilities for those who are inclined to speculate.

Yet the old experiment of Schwann¹⁹ has always been a stumbling-block in the way of any theory that would explain muscular contraction by the action of a force which must increase inversely as the square of the distance between the molecules, for the force of the contraction, as it actually occurs, diminishes as the muscle shortens; and hence we find so good a physiologist as Radcliffe²⁰ reviving, in a modified form, the old hypothesis of Matteucci,²¹ in accordance with which the electrical tension of the fibre, in the state of rest, causes a mutual repulsion of the molecules, and so elongates the muscle, while the contraction is merely the effect of the elasticity of the tissue, which asserts itself so soon as the repulsive force is diminished by the negative variation that precedes contraction.

In consequence of these and other difficulties many physiologists are beginning to regard the electrical phenomena as subordinate accidents of the chemical processes that go on in muscle, and endeavor to explain muscular contraction as resulting directly from these chemical processes themselves. Arthur Gamgee²² has adopted as most probable the chemical hypothesis of Hermann.²³ This assumes the contraction to result from the decomposition of a complex nitrogenous compound supposed to be contained in the muscular tissue, and named inogen. During contraction inogen breaks

down into carbon dioxide, lactic acid, (Fleischmilchsäure,) and gelatinous myosin. The rearrangement of molecules necessary to produce the latter body determines the contraction. Subsequently the gelatinous myosin combines with the necessary materials furnished by the blood, and becomes inogen again. This decomposition and recomposition goes on also while the muscle is at rest, but, as then the gelatinous myosin is reconverted into inogen as rapidly as it is formed, no contraction results.

Du Bois-Reymond declares all this to be merely unsupported hypothesis.²⁴ Gamgee himself admits that it is, after all, not very clear why the gelatinous myosin should contract. Michael Foster,²⁵ who wholly rejects this particular chemical hypothesis, nevertheless seems quite sure that the true explanation will be found to be a chemical one. He insists that muscular contraction is essentially a translocation of molecules, and declares that whatever the exact way in which this translocation is effected may be, it is fundamentally the result of a chemical change, or, as he describes it, "an explosive decomposition of certain parts of the muscle-substance."

The purpose I have in view does not require, fortunately, that I should attempt to decide whether these more purely chemical theories of muscular contraction, or the more purely electrical theories, are best entitled to confidence. My object has been effected, if I have impressed you with the fact that wide differences of opinion still exist as to the nature of the process, and that further investigation is indispensable for the settlement of existing controversies.

The subject just briefly discussed brings us naturally to the consideration of the nature of the action of the motor nerves, by which, in all animals possessed of a muscular and nervous system, the contraction of the muscles is regulated and determined.

The hypothesis which identifies the nervous currents with electricity was propounded in the posthumous work of Hausen²⁶ in 1743, and, notwithstanding all the difficulties and objections it has encountered, still survives in a modified form in many contemporaneous minds. Those who hold to this view appeal in its support to the electrical phenomena actually observed in nerves in accordance with the investigations of Du Bois-Reymond. These observations have long been widely accepted as conclusive proof that natural currents exist in the quiescent nerve of the same general character as those attributed to the quiescent muscle, which I outlined a few minutes ago. The electro-motive force of this current was found

by Du Bois-Reymond²⁷ to be equal to .022 Daniell in the sciatic nerve of the frog. When a nervous impulse passes along the nerve the natural current is diminished; it experiences a negative variation, which, according to Bernstein,²⁸ when the impulse results from a very potent stimulation, may more than neutralize the natural current. The same physiologist has shown that this negative variation moves along the nerves of the frog at the rate of 28 metres per second; that is, at the same rate as the nervous impulse itself, as determined without reference to the electrical phenomena.

As in the case of the muscle-currents, these phenomena have been differently interpreted by Hermann,²⁹ who denies the existence of any natural nerve-current in uninjured nerves, and ascribes those observed in the experiments to the circumstance that the parts of the nerve dead or dying, in consequence of the section, become negative to the living nerve. The negative variation produced by the stimulation of a nerve he explains by assuming that the stimulated part of the nerve becomes, in consequence of the changes resulting from the stimulation, negative to the unstimulated parts. I will not attempt to enter to-night into the merits of the controversy still in progress with regard to this question; nor will I pause to discuss the exceedingly curious and interesting phenomena of electrotonus,³⁰ concerning which, I will only say that the question has even been raised by Radcliffe as to how far these phenomena are peculiar to nerves, and how far they may be regarded as mere phenomena of the electrical currents employed, which would be equally manifested under similar circumstances if a wet string or other bad conductor should be substituted for the nerve.³¹

However these disputes may be ultimately decided; whatever the actual facts with regard to the electrical manifestations in nerves at rest or in action, may ultimately prove to be, there is a group of easily repeated elementary experiments which seem to show pretty distinctly that whatever the nervous impulse may be, it is not merely an electrical current.

It was known already when Haller wrote³² that a string tied tightly around a nerve, although it in no wise interferes with the passage of electrical currents, puts a speedy end to the transmission of nervous impulses. With this old experimental difficulty uncontradicted, it seems strange that anyone should declare at the present time that "the main objections raised to the electrical character of nerve energy is based upon its slow propagation."³³ In fact this

latter objection is altogether a subordinate difficulty which may perhaps be entirely explained away; the main experimental objection does not relate to the velocity, but to the conditions of the propagation of the nervous impulse. If, instead of tying a string around it, the nerve be merely pinched or bruised well with a pair of forceps so as to destroy its delicate organic texture; if it be compressed tightly by a tiny metallic clamp; if it be divided by a sharp knife, and the cut ends brought nicely into contact, or brought in contact with the extremities of a piece of copper wire, it will still conduct electrical currents as well as ever, but can no longer transmit the nervous impulse. So, too, there are certain poisons, such as the woorara, which completely destroy the capacity of the nerve for transmitting nervous impulses, without in the least diminishing its conductivity for electricity.³⁴

In view of these and other practical difficulties, the best instructed modern physiologists no longer attempt to identify the nervous impulse with the electrical phenomena by which it is accompanied. Du Bois-Reymond himself has suggested that the nervous agent "in all probability is some internal motion, perhaps even some chemical change, of the substance itself contained in the nerve-tubes, spreading along the tubes."³⁵ Herbert Spencer came to the conclusion that "nervous stimulations and discharges consist of waves of molecular change"³⁶ flowing through the nerve-fibres; and I suppose that most physiologists at the present time think of the nervous current in some such way as this. Even those who attach most importance to the electrical phenomena will, I take it, agree with Michael Foster, that these "are in reality tokens of molecular changes in the tissue much more complex than those necessary for the propagation of a mere electrical current."³⁷

We do not, however, as yet possess any sufficient foundation of facts on which to build a reasonable hypothesis as to the nature of the molecular disturbances that accompany a nervous impulse. The labors of the physiological chemists have taught us nothing with regard to the changes that go on, except that the axis-cylinder which, in the inactive living nerve is alkaline, becomes acid after long continued activity, or after death.³⁸ We can measure the velocity with which the impulse travels; we can study the conditions under which it arises; we can believe, as I certainly do, that it will ultimately receive a chemico-physical explanation, but its real nature we do not yet know.

So far as we can ascertain, the phenomena of the conduction of nervous impulses by the sensitive nerves are so similar to those of the conduction of motor impulses, that any explanation ultimately adopted for the one will probably apply to the other also. When, however, we ascend to the study of the nervous centres, by which sensitive and motor nerves are connected together, and attempt the interpretation of the complex functions of nerve-cell, ganglion, spinal cord, and brain, we find that none of the hypotheses hitherto brought forward to explain the observed phenomena repose on any defensible chemico-physical basis.

I cannot, of course, undertake to give to-night even the most meagre outline of the wondrous mechanism which physiological experiments show must exist. That reflex actions, co-ordinated muscular movements, and all the complex phenomena of this class, do depend upon a wonderfully complex mechanism, and occur in strict accordance with the ordinary chemical and physical laws, I do not for a moment doubt, and I cordially invite the co-operation of the chemists and physicists to aid the physiologists in the explanation of this mechanism, for we stand only upon the threshold as yet.

If now we turn from the more general discussion of muscular contraction and nervous action, to the consideration of the several functions carried on in animals, by means of special arrangements of the muscular and nervous systems, we continually encounter the preponderating influence of purely physical laws. The introduction of air into the lungs of breathing animals, and its expulsion thence, is effected in a purely mechanical way, while the exchange of the carbon dioxide of the blood with the oxygen of the inspired air occurs in strict obedience to the laws of the diffusion of gases.

The ordinary laws of hydraulics govern the circulation of the blood and lymph, and all the complex visible motions of the body are executed in accordance with the ordinary laws of mechanics; nor is it at all necessary for me to insist upon the purely physical nature of the operations of the organs of the special senses, conspicuously the eye and the ear. For example, so far as concerns the means by which images of external objects are formed sharply upon the retina, the eye is as purely a physical instrument as the telescope or the microscope. But I need not dwell upon this group of phenomena, because the importance of the role of the ordinary physical

laws in this domain is conceded, I suppose, by the extremest of the vitalists of the present day.

We see, therefore, that, with regard to a large part of the phenomena of living beings, there are grounds for affirming either that they have already been satisfactorily explained by a reference to established chemical and physical laws, or at least that they are of such a character that it is reasonable to hope they may be thus explained at some future time. Is it possible, then, to return, as some have done of late years, to the old speculation of Des Cartes, and look upon living beings as mere machines? To do so, it will not suffice to image to yourselves ordinary machines in which fuel yields force. To satisfy the chemico-physical hypothesis of life you must suppose machines that build themselves, repair themselves, and direct, from time to time, new applications of their energy in accordance with changes in the environment; nay, more—machines that accouple themselves together, breeding little machines of the same kind that grow by and by to resemble their parents, and all this self-directed, without any engineer. But even Des Cartes required an engineer—the soul—to run his man-machine, and the logic which compelled him to this view applies just as forcibly to all the modern machine conceptions of living beings.

I have already asserted that there are whole groups of phenomena characteristic of living beings, and peculiar to them, which cannot be intelligently explained as the mere resultants of the operation of the chemical and physical forces of the universe. These phenomena I refer—I avow it without hesitation—to the operations of a vital principle, in the existence of which I believe as firmly as I believe in the existence of force, although I do not know its nature any more than I know the nature of force. If, for convenience, at any time, I compare the living body to a machine, I must compare the vital principle to the engineer—it is the director, the manager if you will, but it does not supply the force that does any part of the work. Let us consider, then, in the remainder of this discourse, the phenomena which indicate the guidance of the vital principle.

The first group of phenomena belonging to this second class are those forced upon our attention whenever we attempt to study the question of the origin of life. It has seemed to some of our contemporaries that, in accordance with the doctrine of evolution, as deduced by Mr. Herbert Spencer from the great truth of the persistence of force, life ought always to arise spontaneously out of inorganic

matter whenever the necessary materials and other conditions of life are brought together. Indeed, if there be nothing more or other in life than force, I confess I do not understand how this conclusion can be logically escaped; and yet, when we come to interrogate nature, we find that, in point of fact, things do not happen so.

The sun may stream all the enormous energy of his rays upon the slime of the Nile, but he generates no monsters; nay, not even a bacterium, except in the presence and under the direction of pre-existing life. Our biological knowledge has so far advanced that it is easy for us to get together mixtures of matter, for the most part derived from pre-existing living beings, which are peculiarly well fitted to supply the materials needed for the building up of a variety of low forms of life, and the extent of our present knowledge of the conditions favorable to the development of these low forms of life is shown by the rapidity with which they do develop from a few individuals to countless millions, if only a few individuals are introduced as parents into our flasks and brood-ovens. The species to which the countless progeny belongs, depends always upon the species of the parents we introduced by design or accident, and if parents of several species are introduced we may imitate on a tiny scale the great struggle for existence, and witness the survival of the fittest. Never, however, has the spontaneous generation, out of inorganic matter, of a single living form been yet observed.

Speculative considerations have, indeed, from time to time led certain enthusiasts to desire earnestly that it might be observed; and when we consider on the one hand the influence of pre-existing bias, and on the other the intricacy of some of the experimental processes in question, it is by no means necessary to charge dishonesty upon those who, from time to time, have actually fancied that their desires have been realized to the extent of the spontaneous generation of bacteria at least. When we consider the immense development of the trade in canned food, which could not exist for a single summer's day, if these experimenters were not mistaken, it will be seen how little need there was for renewed scientific experiment to refute their conclusions; but it is a noteworthy fact that among those who have contributed most by exact research to recent scientific demonstrations of the truth, that life never arises except from pre-existing life, are to be found some of the most earnest and eloquent advocates not merely of the doctrines of evolution, but of its supposed corollary, the chemico-physical hypothesis of life.

I sympathize heartily with those who, recognizing that the supposition of the spontaneous origin of life on our globe is flatly contradicted by the facts of science, have endeavored to escape the difficulty by imagining the earliest parent living forms to have been brought to our earth on the surface of meteoric stones or other cosmical bodies. This hypothesis, put forward originally on purely theoretical grounds, has recently acquired a certain degree of support from the published observations of Hahn and Weinland,³⁹ who believe they have recognized the remains of humble coralline forms in thin sections of meteoric stones collected in Hungary. Yet these observations, if indeed they should prove to be correct, would rather afford indications of the existence of life in other worlds than ours, than show that living forms could survive the high temperature to which such cosmical masses must be exposed during their transit through our atmosphere; and even should we find reasons for ultimately adopting this hypothesis, we should not have solved the problem of the origin of life, but only removed it entirely beyond the domain of further scientific investigation.

If, however, we reject this view, and still mean to support the chemico-physical hypothesis of life, we shall have to resort to a still more improbable supposition. We shall have to suppose that although in the present order of things life can only arise out of pre-existing life, the order of things was at some past time so far different that life could then arise out of inorganic matter; a supposition which implies an instability in the course of nature that is contradicted by all the teachings of science.

I willingly admit that, in view of our present scientific notions of the cosmogony, it is impossible to believe that life always existed upon this planet. I willingly admit that life on the earth must have had a beginning in time. But we do not know how it began. Let us honestly confess our ignorance. I declare to you I think the old Hebrew belief, that life began by a creative act of the Universal Mind, has quite as good claims to be regarded a scientific hypothesis as the speculation that inorganic matter ever became living by virtue of its own forces merely.

If we turn now to the consideration of the processes of growth, we shall find additional reasons for believing in the existence of a vital principle. Let us consider first, in the most general way, the conditions under which those strictly chemical processes occur, to which I have already alluded, and by which the inorganic atoms

are combined into organic matter. I repeat it, I do not for a moment question that the actual force by which these processes are compelled exists in the solar rays, and that it is, after all, the solar energy thus stored up in the vegetable protoplasm and its products that supplies, by its subsequent liberation, all the force manifested by living beings. Yet, let me beg you to observe that in all the myriads of years during which the solar energy has streamed upon the earth, that energy has never, on any occasion that we know of, determined the combination of inorganic atoms into organic matter, except within the substance of already living protoplasm. The water and carbon dioxide and ammonia in the atmosphere and in the soil, come into contact with each other, within the substance of porous inorganic clods on the surface of the soil, much^{as} they do in the substance of protoplasm, and the equal sun warms both alike; but in the clod they remain water, carbon dioxide, and ammonia; in the protoplasm, provided only that it is living protoplasm, they combine into starch or oil, or even into protoplasm itself. The essential condition, then, of this storing up of the solar energy for the subsequent use of living beings is the presence of life, and in these fundamental operations the mighty force of the sun acts, in the fullest sense of the words, the part of the servant of life.

The view thus suggested, that we have here to do with something more than the mere operation of the inorganic forces, is still further strengthened when we come to consider more in detail the phenomena of the growth of living beings, whether plants or animals. The better we become acquainted with these phenomena the more fully we become convinced that we have to do with processes for which the inorganic world affords no parallel.

Linnæus, indeed, declared, "*lapides crescunt*," using the very same phrase which he applied also to plants and animals.⁴⁰ But it is impossible to maintain this assertion without adopting the most superficial view of the growth of living beings, and defining the process to consist merely in increase of size. That this should have appeared reasonable, in the time of Linnæus, need excite no surprise; but it seems strange to find so astute a thinker as Mr. Herbert Spencer repeating the old fallacy in the first chapter of his *Inductions of Biology*, and declaring: "Crystals grow, and often far more rapidly than living bodies."⁴¹ Then, after instancing the formation of geological strata by the deposit of detritus from water,

as well as the formation of crystals in solutions, as examples of growth in the inorganic world, he asks: "Is not the growth of an organism a substantially similar process?" and adds: "Around a plant there exist certain elements that are like the elements which form its substance, and its increase in size is effected by continually integrating these surrounding-like elements with itself; nor does the animal fundamentally differ in this respect from the plant or the crystal."

Now, as opposed to this, I must express my belief that the more we know of the actual details of the process of growth in plants and animals the more clearly it will be seen that this process does differ so fundamentally from that by which a crystal is formed and increases in size, or from any increase in size of inorganic bodies, that the same scientific term cannot, with any propriety, be applied to both, however long popular usage may have given to both a common name. When inorganic bodies increase in size the additional atoms are deposited on their external surfaces; or, if a fluid, after penetrating the interstices of some porous body, deposits there any material held in solution, the mass, indeed, is increased thereby, but not the size. When, however, vegetable protoplasm grows, it does not merely integrate with itself certain elements around it like the elements which form its substance; the needed elements exist in compounds quite unlike itself, and it combines them together into protoplasm in all parts of its mass, so that it grows by a process of intussusception wholly unlike anything that occurs in the inorganic world. In the case of animal protoplasm, the mode of growth by intussusception is the same, but the capability of combining together mere inorganic elements into its own substance is lost; and, besides these, a certain amount of pre-existing vegetable or animal protoplasm must be present in the food, or growth will not go on.

In both cases, when the growth has proceeded to a certain extent—within certain definite limits—a new characteristic phenomenon occurs in a growing mass of vegetable or animal protoplasm; it multiplies by division, its whole mass participating in the act, in accordance with one or other of a few definite methods. This process is repeated again and again. The progeny may separate, without modification, as independent forms, or, as in the case of the more complex organisms, they may cohere together, and the process culminates by groups of them undergoing certain definite and

peculiar transformations, after which further multiplication becomes rare or ceases altogether, and the growth of the complex organism is thus limited.

I cannot, of course, attempt this evening to describe all the known details of the process of growth which I have thus hastily sketched; to give you a really satisfactory account of them would require a series of lectures. But I do not hesitate to say that the more fully you know these details the more unscientific you will think the attempt to class them as in any way similar to the circumstance that inorganic crystalline compounds seem "each to have a size that is not usually exceeded without a tendency arising to form new crystals, rather than to increase the old." It is, at the best, a waste of words to attempt to explain complex phenomena by comparing them to simpler ones which are fundamentally unlike them.

I have but now referred to a process by which, in the growth of the more complex living beings, the small primitive protoplasmic mass, out of which each individual arises, subdivides and produces a numerous brood of protoplasmic masses, at first closely resembling the parent mass, but after a time differing from it more and more, and finally undergoing transformations into definite and peculiar forms. This process, which does not take place in any disorderly manner, but in a very characteristic and definite way in each individual form, is designated by the term development. In point of fact, so far as it consists in the mere growth and multiplication of the individual elements that compose the organism, and the increase in size of the organism itself on account of these processes, it is properly designated by the term growth. In so far, however, as the individual elements are differentiated, and the wonderful architecture of the living being, with its organs and systems, is completed thereby, it is properly designated by the term development.

Nothing like the process of development as thus defined exists in the inorganic world, and in all the attempts at such a comparison that it has been my fortune to meet, the most fundamental facts of the development of living beings have been persistently ignored. Among these fundamental facts I invite your attention especially to the circumstance that there is something in the microscopic mass of protoplasm, out of which, even in the case of the highest and most complex living beings, each individual arises, that goes even further in determining the direction in which the individual

shall develop than the pabulum, or environment, or all the mighty chemical and physical forces that are brought into play as the process goes on. In a word, the individual develops after the pattern of its parent, or not even all the solar energy can compel it to develop it at all.

We are thus brought face to face with the facts of sexual generation, and especially of heredity, with all their wide bearings on the great biological questions of natural selection and the origin of species. Into the details of these large questions the limits of the hour will not permit me to enter. Could I take time to do so, I am satisfied that at every step I should be able to collect for you additional evidence of the existence of a vital principle. Still I regret this the less because most of you, I think, are so familiar with the modern literature of these subjects, and especially with the admirable writings of Mr. Darwin, that I feel sure, if I can succeed in giving you a clear outline of my views, much that I should say, had I time, will suggest itself to your own minds. In a general way, however, when we study, in the history of life upon this globe, the double phenomena of long continued persistence of type, and of slow variation continually occurring, we will find that almost all biologists, whatever their theory of life, explain these phenomena on the one hand by heredity, on the other by the sensibility of the organism to the influence of the environment.

Both heredity and the influence of the environment may be very conveniently studied in those simplest organisms in which each individual consists of a single minute mass of naked protoplasm, as in certain rhizopods, for example, the *amœba*. These tiny creatures produce a progeny which preserves the parental type as closely as is done by the offspring of the higher animals. Their sensibility to the influence of the environment is manifested in several ways. They grow, that is they appropriate materials from the environment, in the way I have already specified; they manifest automatic movements, that is, on encountering food, obstacles, or other disturbing external circumstances, movements result the direction and energy of which are in no wise determined by the character or force of the external influences, or as they may be conveniently termed the stimuli by which these movements are provoked; and finally, simultaneously with the process of growth, a certain metamorphosis, or metabolism, of the protoplasm is continually going on resulting in the formation of excrementitious substances which are continually being excreted.

The processes of growth and metabolism exhibit different degrees of intensity in accordance with variations of the environment, and whatever physical theory of the mode in which the protoplasmic motions are produced we may adopt, the mechanical force manifested can only be supposed to proceed from the decomposition of a part of the protoplasm itself into simpler compounds, that is, from a particular kind of metabolism. Hence you will I think, be quite prepared to hear me speak of all the circumstances in the environment that so act upon living protoplasm as to increase its growth or metabolism, as stimuli, and of the property of living protoplasm by which all its responses to stimuli are guided, as irritability, instead of limiting these terms to the phenomena of automatic movement only, as was formerly done. This irritability of living protoplasm determines the direction in which its internal forces shall be manifested. Speaking of it as I do, perhaps you would wish me to call it sensibility rather than irritability, and I do not know that I should object very strenuously to any one who wished to do this. But however you may name it, it is this vital property of all living protoplasm that produces the sensibility to changes in the environment which has been the main factor in the gradual evolution, during the ages, of the highest and most complex from the simplest and lowest living forms.

Against this view it has been urged with much ingenuity that protoplasm is the material substratum of life, and life merely a property of protoplasm; that is, if the words have any meaning at all, that life is the resultant only of the forces inherent in the inorganic atoms of which the protoplasm is built up. Now, in the first place, no one has ever yet been able to show, by any conceivable synthesis, how the forces known to belong to the several kinds of inorganic atoms of which protoplasm is composed, could by their combination, produce the characteristic phenomena of living protoplasm, namely, the phenomena of irritability, as I have just described them. But, in the second place, this speculation appears to be pretty flatly contradicted by the circumstance that, although protoplasm can only be formed within the substance of previously existing living protoplasm, it can continue to exist, it does continue to exist as protoplasm after it has ceased to live. Not merely can it persist for a time without chemical change as dead protoplasm, it can subsequently serve as food and be reconverted into living protoplasm once more. Bear in mind, however, that this change

can only be effected within the substance of the living protoplasm of the animal that assimilates this food. It is not effected by the chemistry of digestion, that merely makes peptone of the protoplasm; merely makes it soluble enough to pass into the substance of the protoplasmic masses that are to appropriate it. These considerations, then, would seem to show that the material, protoplasm, cannot be rightly believed to be of itself the cause and essence of life.

If I should pause here, it seems to me that I should have brought forward adequate reasons for believing in the existence of a vital principle. But I cannot pause here. Beyond and above all this there is another great group of phenomena peculiar to living beings—a group of phenomena concerning which, in my own individuality, I have knowledge at least as positive as any I possess of the existence of force, and which I am led, by a logic quite as convincing as that by which any general proposition with regard to the external world is proven, to believe exists in like kind and degree in the case of my fellow-man. I refer to the phenomena of the perceiving, emotional, willful, reasoning human mind. Into the argument that makes it highly probable that a similar but less and less perfect mind exists in the animal world, and identifies with mind the sensibility of the lowest animal forms, and even that of vegetable protoplasm, I will not attempt to enter to-night. Mr. Herbert Spencer himself has presented this view with so much ingenuity, that, without committing myself to an approval of all his details, I must content myself by referring you to his writings for one of the best discussions of this matter. It will be sufficient for my present purpose to close this discourse by the presentation of a few considerations in relation to mind as it exists in man.

For myself I know mind only as a manifestation of life, if indeed it is not the essence of life. But the old doctrine of Epicurus, handed down to us in the poem of Lucretius, that in some way or fashion mind is produced by the clashing together of the atoms, has been boldly revived of late years, and transmuted into a form more plausible to modern thought, although just as unsupported by any actual knowledge of facts.

No one has done this more boldly or more cleverly than Mr. Herbert Spencer has done in his *First Principles*, and of course you are all familiar with the ingenious argument, in favor of this view, which runs through that masterly work. It would be, from many

points of view, profitable, but it would be a very laborious task to attempt the critical discussion of his argument. It must suffice, for my present purpose, to point out that two of the fundamental assumptions upon which that argument is based are wholly undemonstrated. The first assumption is, that mind is itself a force;⁴² the second, that mind cannot be conscious of itself, but only of the external world.⁴³

If I could bring myself to believe that mind is, in any proper sense of the word, a force, and that such popular metaphorical expressions as mental force or mental energy accurately described the phenomena, I should certainly expect to find at least some shadow of proof for Mr. Herbert Spencer's assertion, that mental operations fall within the great generalization of the correlation and equivalence of the forces. On the contrary, however, you will find, on reading his lucid periods, that his whole argument relates to those physical conditions in the organs of sense and in the muscular and nervous systems, which are the antecedents of perception—which are, in fact, the things really perceived—and in no sense constitute the perceiving mind. Between strictly mental phenomena and the physical forces no one has as yet even attempted to establish a numerical equivalent; nay, more, the correlation of thought with the physical forces is not only undemonstrated, it is utterly unthinkable. You can conceive several different ways, it matters not whether true or false, in which the motions we know as heat might be converted into those we know as light, and so on with the other physical forces; but you cannot represent mentally any intelligible scheme by which any of the physical forces can be converted into the simplest or most elementary thought.

As to the question of self-consciousness, it seems as if the great philosopher were reasoning in a circle. He first assumes that the fundamental condition of all consciousness is the antithesis between subject and object,—which is true only with regard to consciousness of perception, the form of consciousness by which we become acquainted with the non ego,—and then he concludes that there can be no consciousness of the ego because it cannot fulfil these conditions. That is, in a word, he denies consciousness of the ego, because it is not consciousness of the non ego. Really it appears to me that, as against such a philosophy as this it is not amiss to appeal to "the unsophisticated sense of mankind," of which Mr. Mansel speaks.⁴⁴ But there is fortunately a better philosophy than

this; a philosophy which recognizes the validity of the mind's self-consciousness as at least fully equal to the validity of its consciousness of the conditions of the body by which it obtains a knowledge of the external world. By this self-consciousness I know, with a certainty which no doubt can ever disturb, that I have a mind; and by rightly applying my reasoning powers to the data of my self-consciousness, I can learn much that will be useful to me with regard to my mental processes and the methods of employing them. But here I have to stop. I can learn nothing, whether by consciousness or by reasoning, with regard to the real nature of my conscious mind, and however much it may long for immortality, neither philosophy nor science afford any foundation of proof upon which it might build its hopes.

I have already said that I know mind only as a manifestation of life. Its operations are intimately connected with the chemical and physical phenomena of living beings, and it exercises over them a certain directing influence, the nature of which we do not understand. The obedience of our voluntary muscular actions to the mandates of the guiding will is a familiar illustration of this directing influence. On the other hand, all the knowledge of the external world on which the mind exerts its reasoning power reaches it through the organs of sense and the nervous system. Indeed, our studies of the phenomena of sensation compel us to conclude that what our mind really perceives, when it takes cognizance of the external world, is merely the ever-changing panorama of our own cerebral states. It should be anticipated, therefore, that disturbed or morbid conditions of the brain would lead to irregular or disorderly mental operations; and the circumstance that this really happens, affords no better proof of the materiality of thought than is afforded by the circumstances of our ordinary normal thought.

So, too, since the cerebral changes, which the mind perceives, are themselves of a purely chemico-physical nature, it should be anticipated that, like the metabolic processes in other tissues, they would be accompanied by an increased excretion of characteristic waste-products, by evolution of heat and by afflux of blood. Experimental investigation has been directed to each of these points, and some important observations have no doubt been made; but much of the testimony is conflicting, and our knowledge is still so

incomplete that further inquiry in each direction is greatly to be desired.

This is particularly the case with regard to the chemical questions connected with the metabolism of the brain. In the first place our knowledge of the chemical composition of brain-substance is still in its infancy. The view that its characteristic ingredient is the phosphorized nitrogenous body described in 1865 by Liebreich under the name of protagon has been strongly controverted by Diaconow, Hoppe-Seyler, and Thudicum, while recently it has been reaffirmed by Gamgee, and Blankenhorn.⁴⁵ But even should this view turn out to be well founded, we have yet everything to learn with regard to the transformations protagon undergoes during functional activity, and the nature of the resulting waste products.

Long before Liebreich announced the existence of protagon, however, the attention of the physiological chemists had been directed to the prominence of phosphorous as an element in the composition of the cerebral substance, and it had been suggested that a part of the phosphoric acid excreted in the urine might be derived from the metabolism of the brain. As early as 1846 Bence Jones⁴⁶ had observed an excess of phosphatic salts in the urine during certain brain diseases, notably acute inflammations, and an observation published in 1853 by Mosler⁴⁷ appeared to indicate that a similar excess followed intellectual activity.

Byasson [1868] in his essay on the relation between cerebral activity and the composition of the urine,⁴⁸ reports a number of urinary analyses which support the view that the excretion of alkaline phosphates by the kidneys is habitually increased during mental work. This opinion has also received a certain degree of support from the more recent papers of Zuelzer⁴⁹ and Struebling;⁵⁰ nevertheless it is impossible to study the detailed observations upon which it is based without feeling how meagre and unsatisfactory the evidence relied upon really is. It is at best only sufficient to indicate the importance of further inquiry, and to suggest the necessity of avoiding certain obvious errors of method which complicate and obscure the results of the investigations hitherto made.

The opinion that mental effort is accompanied by an increase in the temperature of the brain was first propounded by Lombard in 1867. Using a delicate thermo-electric apparatus of his own con-

trivance, he observed during mental effort a rise of the surface temperature of the head, which sometimes amounted to as much as one-twentieth of a degree centigrade.⁵¹ Subsequent and more elaborate investigations confirmed him in this conclusion, which has also been supported by observations made with thermo-piles by Schiff and Bert, as well as by the use of surface thermometers in the hands of Broca and L. C. Gray of Brooklyn.⁵² Gray claimed to have observed a maximum rise of as much as two and a half degrees Fahrenheit. These physicians and some others have also investigated the relative temperature of the two sides of the head, of different regions on each side, the variations produced in certain regions by voluntary muscular movements, and those resulting from localized brain diseases.⁵³

To attempt any discussion of these interesting studies, and their conflicting results, would lead me altogether beyond my prescribed limits. It is enough for my present purpose to point out that the recent investigations of François Frank⁵⁴ would seem to indicate that the variations of temperature actually observed are chiefly due to changes in the cerebral circulation. Plunging suitable sounds, connected with a thermo-electric apparatus, into the brains of animals to different depths, Frank found that the deeper parts of the brain are always warmer than its superficial layers. The superficial layers are continually cooled by radiation, and their temperature is a degree, or more than a degree centigrade, lower than that of the deeper parts. Even these, however, are $.1^{\circ}$ to $.2^{\circ}$ centigrade cooler than the blood in the thoracic aorta, and it will therefore readily be understood that a relaxation in the muscular coats of the cerebral vessels, permitting the more rapid circulation of a larger quantity of blood, would be promptly followed by an increase in the temperature of the superficial parts of the brain. None of the observers I have cited have reported a surface temperature of the head during mental effort that is too high to be accounted for in this way; and if, as I willingly concede is probable, there is really an increased heat-production in the brain itself, it is wholly masked by the more considerable change due to afflux of blood.

Now a consideration of the phenomena of blushing, and certain well known sensations in the head, might lead us to expect that emotional and mental conditions would prove to be attended by increased activity in the circulation of the blood in the brain; yet many difficulties have hitherto been encountered in the attempt to

demonstrate experimentally that this is true. Mosso of Turin supposed that he had succeeded in doing this with his plethysmograph.⁵⁵ The instrument is essentially a cylinder of water, into which the arm is introduced and so fastened in place by a caoutchouc membrane that the slightest increase or diminution in the volume of the arm will cause the rise or fall of the water, through a tube connected at one end with the interior of the cylinder and at the other with a suitable recording apparatus. The pen or pencil of this apparatus inscribes a curve that rises or falls with the fluid in the tube. Among the curious observations made with this instrument, Mosso reports that the mental operations and emotions of the persons he experimented on were accompanied by a fall of the curve, which he regarded as proof that more blood goes to the brain and less to the arm during emotion, or mental action, than at other times. But the following year these observations were repeated with great care, and with an improved plethysmograph by Basch, of Vienna,⁵⁶ who failed to verify them. Most of the phlegmatic Germans on whom he experimented did sums in their heads, and otherwise exerted their minds, without producing the slightest modification of the curve, and none of them appear to have been as emotional as Dr. Pagliani, of whom Mosso relates that, his arm being in the plethysmograph, when the revered Prof. Ludwig entered the room the curve fell as if he had received an electric shock. Basch has cautiously investigated the causes of the varying quantity of blood in the arm in these experiments, and has clearly shown how many general and local conditions concur in producing the result. Especially has he emphasized the effect of variations in the abdominal circulation, which appear to exercise a much more considerable influence upon the size of the arm than any changes that occur in the brain.

In subsequent works Mosso has stated that during mental effort, such, for example, as is required to multiply small numbers in the head, the radial pulse, as recorded by the sphygmograph, is shown to become somewhat more frequent, and the recording lever does not rise so high as at other times.⁵⁷ Thanhoffer, who has pointed out that in these observations the influence of respiration on the pulse was neglected, concluded, nevertheless, from his own sphygmographic observations, that after due allowance is made for this complicating influence, it must be conceded that cerebral activity does exercise a certain effect upon the pulse, and in the direction

stated.⁵⁵ Eugène Gley, in a recently published essay, claims to have obtained similar results, and states that at the same time the sphygmographic trace of the carotid artery shows a higher upstroke of the recording lever, and other indications of dilatation of the vessel.⁵⁹ While these observations are not sufficiently numerous, or free from objections, to be accepted without question as proof that an increased supply of blood to the brain invariably accompanies mental effort, they are certainly sufficient to encourage further labor in this interesting field.

But if the arguments in favor of the purely material nature of our mental operations that have been based upon the imperfect results of the three lines of investigation I have just referred to must be rejected as utterly fallacious, what shall we say of the logic that attempts to draw a similar conclusion from the results of those inquiries into the phenomena of personal equation which aim at determining the time that must be allowed for the mental operation involved?⁶⁰ Do we, then, indeed need the beautiful experiments of Hirsch and Donders⁶¹ to prove that thought occupies time? Whence, indeed, do we derive our primitive conceptions of time save from our consciousness of the succession of thought? And how could even the shortest time be occupied by even an infinite number of thoughts if each thought did not occupy at least some time, however brief?

I have thus, gentlemen, attempted to show that we are logically compelled to invoke the existence of a vital principle in order to account for certain important groups of phenomena occurring in living beings which cannot possibly be explained by the chemical and physical forces of the universe. These phenomena form a series, at one end of which we find the mere irritability or sensibility of the humblest mass of living protoplasm; at the other the reasoning faculty of the human mind. From the one extreme of this series to the other I recognize the manifestations of the vital principle. I willingly confess that I know nothing of the ultimate nature of this principle, except that it must be very different from the chemical and physical forces whose operations I have learned to recognize in the organic as well as in the inorganic world; nevertheless I am compelled by my study of the phenomena to conclude that it exists. I know that Mr. Huxley, only last summer, declared in the International Medical Congress at London, that the doctrine of a vital principle is the "asylum ignorantiae of physiologists;"⁶²

but this ancient sarcasm has now been applied to so many things that it has long since lost whatever sting it may once have possessed, when it was fresh and new. And I also know that one of the chief characteristics of true science is the sharpness with which it enables us to discriminate between that which we have proven and really know and that which we have not proven and do not know. Better far is it, and a thousand times more in accord with the simple honesty of science, to acknowledge frankly the truth that phenomena occur in living beings which the inorganic forces do not explain, than to mistake our wishes for discoveries, to convert conjectures into dogmas, or, worst of all, to transform an undemonstrated hypothesis into a superstitious, aggressive, and intolerant creed.

Nor will the soundness of the conclusions, at which the present generation shall arrive as to this matter, be without its practical effect upon methods of biological research, and the consequent future progress of biological science. It is not a mere metaphysical subtlety, but a subject of practical importance that I have asked you to consider to-night. For if the chemico-physical hypothesis of life be true, the only road of progress in biology lies through the chemical and physical laboratories. Now, I have already this evening more than once indicated how highly I esteem the class of biological work that has already been done in these laboratories, and I have endeavored to show how large is the unexplored biological field that can be explored only in this manner. But in addition to all that we can ever hope to do in this direction—and I insist upon its importance—I insist also upon the importance of other lines of work: I insist upon the importance of the systematic study of the phenomena of growth and development, of generation and heredity, of sensibility and mind. All that can thus be learned we need to know, and not merely for its own sake. This knowledge is indispensable to the right interpretation of the succession of life upon the globe in the past, and the successful direction of the interference of the human will with the future succession of life upon the globe in accordance with human necessities. We shall make slow progress in this direction if we confine our efforts to the application of chemistry and physics to those phenomena of living beings that can be thus explained. The other phenomena, not thus explicable, must also be studied in detail, arranged into orderly groups, and made the basis of such inductions as our

knowledge of them may warrant. It is only by pursuing this method that we can hope ultimately to acquire, with regard to the phenomena of living beings, that power to predict, which is the criterion of true science, and that power to control, which we so sorely need.

NOTES.

¹ GEORGE F. BARKER—*Some Modern Aspects of the Life Question*. Address as President of the Amer. Ass. for the Advancement of Science. Boston meeting, August, 1880. Proceedings, Vol. XXIX, Part I, p. 23.

² GALEN—*Quod animi mores corporis temperamenta sequantur*, Cap. 3. [Kühn's Edit., T. IV, p. 772.]

³ ST. GEORGE MIVART—*The Cat*. London, 1881, p. 387.

⁴ First taught by J. R. MAYER—*Die organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel: Ein Beitrag zur Naturkunde*. Heilbronn, 1845.

⁵ See, for example, M. FOSTER—*Text Book of Physiology*, 2d Edit., London, 1878, p. 355.

⁶ BARKER—*op. cit.*, *supra*.

⁷ See H. SENATOR—*Unters. über die Wärmebildung und den Stoffwechsel*, Archiv. für Anat. Phys. und wiss. Med., 1872, S. 1.

⁸ FOSTER—p. 368, *op. cit.*, *supra*.

⁹ L. LANDOIS—*Lehrb. der Phys. des Menschen*, Vienna, 1879, S. 402.

¹⁰ L. HERMANN—*Handb. der Phys.*, Bd. I, Th. 1, S. 242.

¹¹ EMIL DU BOIS-REYMOND—*Unters. über thierische Elektrizität*, Berlin, 1848-60, and *Gesammelte Abhandl. zur allgemeinen Muskel- und Nervenphysik*, Leipzig, 1875-77.

¹² DU BOIS-REYMOND—*Ges. Abhandl.*, Bd. II, S. 243.

¹³ BERNSTEIN—*Unters. über den Erregungsvorgang in Nerven- und Muskelsysteme*, Heidelberg, 1871; also Du Bois-Reymond's Archiv, 1875, S. 526; Hermann in Pflüger's Archiv, Bd. X, 1875, S. 48.

¹⁴ L. HERMANN—*Weitere Unters. zur Phys. der Muskeln und Nerven*, Berlin, 1867; also *Handb. der Phys.*, Bd. I, Th. I, Leipsic, 1879, S. 192 *et seq.*

¹⁵ HERMANN—*Handb. der Phys.*, Bd. I, Th. I, S. 215.

¹⁶ ENGELMANN—*Pflüger's Archiv*, Bd. XV, 1877, S. 116 *et seq.*

¹⁷ DU BOIS-REYMOND—*Ges. Abhandl.*, Bd. II, S. 319 *et seq.*

¹⁸ MAYER—*Müller's Archiv*, 1854, S. 214; AMICI (1858)—Translation in *Virchow's Archiv*, Bd. XVI, 1859, S. 414.

¹⁹ SCHWANN—in *Müller's Handb. der Phys.*, 1837, Bd. II, S. 59.

²⁰ C. B. RADCLIFFE—*Dynamics of Nerve and Muscle*, London, 1871.

²¹ MATTEUCCI—*Lectures on the Physical Phenomena of Living Beings*, (translated by J. Pereira,) London, 1847, p. 333.

²² ARTHUR GAMGEE—*A Text Book of the Phys. Chemistry of the Animal Body*, Vol. I, London, 1881, p. 418.

²³ L. HERMANN—*Grundriss der Phys. des Menschen*, 5te. Aufl., 1874, S. 231.

²⁴ DU BOIS-REYMOND—*Ges. Abh.*, Bd. II, S. 320.

²⁵ FOSTER—*op. cit.*, p. 79 *et seq.*

²⁶ C. A. HAUSEN—*Novi profectus in historia electricitatis*, Leipsic, 1743. I cite from DU BOIS-REYMOND—*Unters. über thierische Elektrizität*, Bd. II, Berlin, 1849, Th. I, S. 211.

²⁷ DU BOIS-REYMOND—*Ges. Abh.*, Bd. II, S. 250.

²⁸ BERNSTEIN—*op. cit.*, *supra*.

²⁹ HERMANN—*loc. cit.*, note ¹⁴, *supra*; also *Handb. der Phys.*, Bd. II, Th. I, Leipsic, 1879, S. 144 *et seq.*

³⁰ See especially DU BOIS-REYMOND—*Unters.*, Bd. II, Th. I, S. 289, and PFLÜGER—*Unters. über die Physiologie des Electrotonus*, Berlin, 1859: An excellent summary of the observations (with the literature) is given by HERMANN—*Handb. der Physiologie*, Bd. II, Th. I, S. 157 *et seq.*

³¹ RADCLIFFE—p. 74 *et seq.*, *op. cit.*, *supra*.

³² A. VON HALLER—*Elementa Physiologia*, Lib. X, Sect. VIII, § 15, T. IV, Lausanne, 1762, p. 380. He cites as authority the essay of LE CAT, crowned by the Berlin Academy in 1753. [We have in the S. G. O. Library the Berlin edition of 1765, *Traité de l'existence, etc., du fluide des nerfs, etc.*]

⁸³ BARKER—p. 8, *op. cit.*, *supra*.

⁸⁴ CLAUDE BERNARD—*Leçons sur la Phys. et la Path. du système nerveux*, Paris, 1858, T. I, p. 157 and p. 224.

⁸⁵ Translation of a lecture given by E. Du Bois-Reymond at the Royal Institution, London, in Appendix No. 1 of H. BENCE JONES' *Croonian Lectures on Matter and Force*, London, 1868, p. 130.

⁸⁶ HERBERT SPENCER—*The Principles of Psychology*, Vol. I, New York, 1871, p. 95. Compare also his *Principles of Biology*, Vol. II, New York, 1867, p. 346 *et seq.*

⁸⁷ FOSTER—p. 79, *op. cit.*, *supra*.

⁸⁸ A. GAMGEE—p. 447, *op. cit.*, *supra*.

⁸⁹ O. HAHN—*Die Meteorite und ihre Organismen*, Tübingen, 1881. I cite the Jour. of the Royal Mic. Society, October, 1881, p. 723.

⁴⁰ "Lapides crescunt, Vegetabilia crescunt et vivunt, Animalia crescunt, vivunt et sentiunt." This phrase occurs in the first edition of the *Systema Naturæ*, Leyden, 1735. I cite the reprint of FÉE, Paris, 1830, p. 3, as well as the second Stockholm edition, 1740, p. 76. The expression is replaced in the later editions by more guarded language.

⁴¹ HERBERT SPENCER—*The Principles of Biology*, Vol. I, New York, 1866, p. 107.

⁴² HERBERT SPENCER—*First Principles*, Amer. Ed., New York, 1864, p. 274.

⁴³ HERBERT SPENCER—*op. cit.*, p. 65 *et seq.*

⁴⁴ As cited by Mr. HERBERT SPENCER, *loc. cit.*, last note.

⁴⁵ GAMGEE—p. 425 *et seq.*, *op. cit.*, *supra*.

⁴⁶ HENRY BENCE JONES—*On the variations in the alkaline and earthy phosphates in disease*, Phil. Trans. for 1846, p. 449.

⁴⁷ MOSLER—*Beitraege zur Kenntniss der Urinabsonderung*, etc., Inaug. Diss., cited in Canstatt's Jahresbericht, 1853, Bd. I, S. 134.

⁴⁸ H. BYASSON—*Essai sur la relation qui existe à l'état physiologique entre l'activité cérébrale et la composition des urines*, Paris, 1868.

⁴⁹ W. ZUELZER—*Ueber das Verhältniss der Phosphorsäure zum Stickstoff im Urin*, Virchow's Archiv, Bd. 66, 1876, S. 223.

⁵⁰ STRUEBLING—*Ueber die Phosphorsäure im Urin*, Archiv. für exp. Path. und Pharm., Bd. VI, 1876-7, S. 266.

⁵¹ J. S. LOMBARD—*Experiments on the relation of heat to mental work*, The New York Medical Journal, Vol. V, 1867, p. 199.

⁵² J. S. LOMBARD—*Experimental researches on the temperature of the head*, Proc. of the Royal Society of London, Vol. 27, 1878, p. 166; IDEM—*The regional temperature of the head*, London, 1879; IDEM—*Experimental researches on the temperature of the head*, London, 1881. MORITZ SCHIFF—*Recherches sur l'échauffement des nerfs et les centres nerveux à la suite des irritations sensorielles et sensibles*, Archives de Physiol. norm. et path., T. III, 1870, p. 5 et seq. BERT—*Communication to the Société de Biologie*, read Jan. 18, 1879, in Gazette Hebdomadaire, Jan. 24, 1879, p. 63. BROCA—*Communication to the French Association for the Advancement of the Sciences*, at the Havre meeting of 1877, in Gaz. Hebd., Sept. 7, 1877, p. 577; also Gaz. Méd. de Paris, 1877, p. 457; IDEM in London Med. Record, Jan. 15, 1880. L. C. GRAY—*Cerebral Thermometry*, The New York Med. Jour., Vol. 28, 1878, p. 31; also Chicago Jour. of Nervous and Mental Diseases, Vol. VI, 1879, p. 65.

⁵³ See, besides the papers cited in the last note, C. K. MILLS in The New York Med. Record, Vol. 14, 1878, p. 477, and Vol. 16, 1879, p. 130; MARAGLIANO and SEPPELLI—*Studies on cerebral thermometry in the insane*, translated by J. Workman, The Alienist and Neurologist, St. Louis, Jan., 1880, p. 44 et seq.; R. W. AMIDON—*The effect of willed muscular movements on the temperature of the head*, Archives of Medicine, April, 1880, p. 117.

⁵⁴ FRANÇOIS FRANK—*Communication to the Société de Biologie*, May 29, 1880, in Gaz. Hebd., June 11, 1880, p. 392.

⁵⁵ ANGELO MOSSO—*Sopra un nuovo metodo per scrivere i movimenti dei vasi sanguigni nell'uomo*, Atti della Reale Accademia della Scienza di Torino, T. XI, Nov. 14, 1875. I have not obtained access to the original, but find an abstract in the Archives de Phys. norm. et path., 1876, p. 175. See also BARKER, p. 12, *op. cit.*, *supra*.

⁵⁶ BASCH—*Die volumetrische Bestimmung des Blutdrucks am Menschen*, Stricker's Med. Jahrb., 1876, S. 431. See also ROLLET in HERMANN'S *Handb. der Phys.*, Bd. IV, Th. 1, Leipsic, 1880, S. 306.

⁵⁷ MOSSO—*Die Diagnostic des Pulses in Bezug auf die lokalen Veränderungen desselben*, Leipsic, 1879; also by the same, *Sulla circolazione del sangue nel cervello dell'uomo*, Rome, 1880.

⁵⁸ THANHOFFER—*Der Einfluss der Gehirnthätigkeit auf den Puls*, Pflüger's Archiv., Bd. XIX, 1879, S. 254.

⁵⁹ EUGÈNE GLEY—*Essai critique sur les conditions physiologiques de la pensée*.

État du pouls carotidien pendant le travail intellectuel, Archives de Phys. norm. et path., Sept.-Oct., 1881, p. 741.

⁶⁰ BARKER—p. II, *op. cit.*, *supra*.

⁶¹ HIRSCH—*Détermination télégraphique de la différence de longitude entre les observatoires de Genève et de Neuchâtel*, Genève et Bale, 1864. DONDERS—in Reichert and Du Bois-Reymond's Archiv., 1868, p. 657.

⁶² T. H. HUXLEY—*The connection of the Biological Sciences with Medicine*, The Popular Science Monthly, October, 1881, p. 800.

At the conclusion of the reading the thanks of the Society were voted to the President for his able and instructive address.

208TH MEETING. (11TH ANNUAL MEETING,) DECEMBER 17, 1881.

The President in the chair.

Forty-four members present.

The minutes of the last annual meeting were read and adopted.

The Secretary, Mr. THEODORE GILL, read the list of members who had been elected since the last annual meeting.

The Treasurer read to the Society his report upon the receipts, expenditures, and remaining funds of the Society for the year now about to close. He also read the list of members whose dues had been paid.

The Chair then reported to the Society a resolution of the General Committee, which is as follows:

Resolved, That the President be requested to ask the Society to appoint a committee to audit the Treasurer's report, and to communicate the result of their audit to the Society at its next meeting.

- In accordance with this request, and also with that of the Treasurer, it was moved and carried that the Chair appoint a committee of three for the purpose named in the resolution.

The Chair appointed a Committee of Audit, consisting of Messrs. John Jay Knox, G. K. Gilbert, and Robert Fletcher.

Mr. THORNTON A. JENKINS then offered the following resolution:

Resolved, That all persons who have resigned membership in the Society, or failed in their duties as provided for in the rules of the

Society, shall be dropped from the succeeding published list of members.

By a vote of the Society this resolution was referred to the General Committee.

The Society then proceeded to ballot for officers for the ensuing year, and the following officers were elected:

<i>President,</i>	WILLIAM B. TAYLOR.	
<i>Vice-Presidents,</i>	J. E. HILGARD.	J. C. WELLING.
	J. J. WOODWARD.	J. K. BARNES.
<i>Treasurer,</i>	CLEVELAND ABBE.	
<i>Secretaries,</i>	THEODORE N. GILL.	MARCUS BAKER.

MEMBERS OF THE GENERAL COMMITTEE.

J. S. BILLINGS.	GARRICK MALLERY.
C. E. DUTTON.	SIMON NEWCOMB.
J. R. EASTMAN.	J. W. POWELL.
E. B. ELLIOTT.	C. A. SCHOTT.

WILLIAM HARKNESS.

The rough minutes of the meeting were then read and approved, and the Society adjourned.

209TH MEETING.

JANUARY 14, 1882.

The President, WM. B. TAYLOR, in the chair.

Upon taking the chair President-elect TAYLOR offered a few remarks, and thanked the Society for the honor conferred upon him.

The minutes of the 207th meeting—the 208th being the annual meeting—were then read and approved.

A communication by Mr. BENJ. ALVORD was read, entitled

CURIOUS FALLACY AS TO THE THEORY OF GRAVITATION.

Some years since I noticed in a text book on astronomy, used in one of the most celebrated colleges in the United States, a pretended demonstration that the attraction of gravitation *must* vary inversely as the square of the distances. It was continued in several editions down to about 1850, when that portion was omitted. I always sup-

posed that the author copied it from some old authority; that he was not guilty of inventing it, abused as it was.

In "Hind's Dictionary of Arts and Sciences" (one volume, folio, London, 1769, copy in the Congressional Library) it is found under the article "Attraction."

The first named author announced that "Gravity at different distances from the east *must* vary inversely as the square of the distances." He proceeded substantially as follows:

"The total amount of attraction exerted by the earth upon bodies exterior to it is the same as though that force was all concentrated in the centre. But a force or influence which proceeds in right lines from a point in every direction is diminished as the square of the distance is increased. For, let the centre of the earth be the vertex of a pyramid, cut said pyramid by two parallel bases at different distances from the vertex, making two similar pyramids. *Whatever the nature of gravity, its influence at the distance of each base must be equally diffused over the base. Therefore its intensity or force will be as much less at the greater base, as contrasted with its influence at the nearer and lesser base, as the surface of the latter is to the surface of the former.* But the surfaces of these bases are to each other as the squares of their distances from the vertex. Therefore the force of gravity varies inversely as the square of the distances.—Q. E. D."

Actually he placed Q. E. D. to it as if it was a mathematica, demonstration!

He afterwards said:

"The intensity of light at different distances from the radiant varies inversely as the square of the distances. This proposition is proved in the same manner as that respecting gravity, the reasoning in which applies to *all* emanations from a centre."

Subsequently, when he got to refer to the laws of Kepler, he said:

"They, therefore, became known as *facts* before they were demonstrated mathematically. The glory of this achievement was reserved for Newton, who proved that they were necessary results of the law of universal gravitation."

This sentence would have astonished Newton! It places the cart before the horse. From the empirical laws of Kepler the theory of gravitation was mathematically derived by Newton. Not the reverse. What a confusion of ideas that Kepler's laws could both be demonstrated mathematically and observed as facts? How it be-

littles the labors of Newton, who should have made his discovery (*de novo* from his own breast) by a geometrical process and not from the observed facts!

But my principal object in referring to this curious fallacy was to give an attempt of my own to show its fallacy by a "*reductio ad absurdum*."

I can prove by an entirely similar process, with equal plausibility, that the force of gravity must vary inversely *as the cubes of the distances*. Instead of a pyramid take a cone. Let the centre of the earth be the vertex of a cone. Place two spheres or molecules of different sizes,* tangent to the cone, at different distances from the vertex. *Whatever the nature of gravity, its influence at the distance of each sphere must be equally diffused throughout the solid contents or volume of each sphere. Therefore its intensity or force will be as much less at the greater sphere, as contrasted with its influence at the nearer and smaller sphere, as the volume of the latter is to the volume of the former.* But these volumes or solid contents vary as the cubes of their radii, or as the cubes of their distances from the vertex. Therefore the force of gravity varies inversely as the cubes of the distances.

The oracular "Q. E. D." could have been placed to this fallacy with full as much propriety as in the former case, for I have used nearly identical words. Of course they are both pure assumptions. Neither are mathematically true, and the one destroys the other, as they are contradictory. But the first is true as arrived at by severe induction from the observed facts.

If I was a professor of logic, I should give these as specious examples of the danger of false premises, and of the ease with which they could be manufactured.

Indeed, the authors first named would imply that there could in the science of mechanics be no central forces, no empirical laws. Indeed, they would reduce the whole planetary system, the whole cosmos, to a geometrical necessity; and they would lose that interesting exposition in physical astronomy as to the wisdom and beneficence exhibited in the planetary system as it exists.

In the well-known discussion of central forces by Poisson, the equation of the curve when referred to co-ordinate axes is ascer-

*The word molecules, being now a favorite word with the physicists, might suit the casuist a little better.

tained, and the change of one constant in the equation causes a change in the nature of the curve. If the law varied *directly as the distance*, the orbits of the planets would be ellipses as now, (but the sun would be at the centre, and not at one foci,) and they would all revolve in the same period about the sun, and on the surface of any planet no attraction towards its centre would exist. This curious result would follow: that any object projected into the air would immediately be carried from the earth, and would perpetually revolve as a satellite, like the moon, around it. All terrestrial objects would be unsettled and float about in the air in the utmost disorder.

If, on the contrary, the law varied *inversely as the cube of the distance*, (according to that precious second fallacy above set forth,) each planet would describe a spiral orbit, (if at first projected towards the sun,) continually winding and winding towards the sun; or, if perchance projected at first *from* it, would move in a spiral curve, causing it to recede farther and farther from the sun; and the eye of Omniscience alone could trace its final wanderings. What a contrast, all these suppositions, to the order, stability, beauty, and beneficence of our planetary system as it exists!

The next communication was by Mr. M. H. DOOLITTLE

ON THE GEOMETRICAL PROBLEM TO DETERMINE A CIRCLE
EQUALLY DISTANT FROM FOUR POINTS:

"Describe a circumference equally distant from four given points; the distance from a point to the circumference being measured on a radius or radius produced. In general there are four solutions." (Chauvenet's Geometry, problem 110.)

These four solutions were undoubtedly obtained in accordance with the conception of three given points all either inside or outside of the required circumference. Three other solutions may be obtained from the conception of two given points inside and two outside. Mr. Marcus Baker has suggested that a distance may properly be measured from a given point through the centre of the circle to the opposite side of the circumference. This interpretation increases the number of solutions to fourteen.

This communication gave rise to a brief discussion, participated in by Messrs. HARKNESS, NEWCOMB, and BAKER, the latter pointing out that the problem appears among the exercises of Rouché

and Comberousse's *Traité de géométrie élémentaire*, (2d ed., p. 113, Ex. 124,) a source from which Prof. Chauvenet drew many of his exercises. In Chauvenet's *Geometry* this problem appears as Exercise 110, page 308, with the statement that there are in general *four* solutions. This statement does not occur in the French work cited, and, therefore, the error appears to be due to Chauvenet himself, a thing somewhat noteworthy, as Chauvenet's works are in general very accurate.

Mr. ALVORD then remarked

ON SOME OF THE PROPERTIES OF STEINER'S "POWER-CIRCLE."

After the consideration of this communication the report of the Auditing Committee, appointed at the 208th meeting, was called for, and, in the absence of the chairman, Mr. Knox, was presented by Mr. Fletcher. The following is the report:

WASHINGTON, January 13, 1882.

Mr. President and Gentlemen

of the Philosophical Society of Washington:

We, your committee, appointed at the annual meeting, December 17th, 1881, to audit the report of the Treasurer for the years 1880 and 1881, have the honor to submit the following report:

We have examined the statement of receipts of dues from members and of interest on bonds, and find the former to be \$1,175 and the latter \$125, as appears in the Treasurer's statements of accounts for the years 1880 and 1881.

We have examined the vouchers for disbursements for the same period, and find them correct.

We have compared the return checks with the vouchers and with the entries in the bank book, and find them correct.

We have examined the bank book, and found the balance as set forth to be correct, said balance, deducting the amount of two checks not yet returned, being \$320.16, with Messrs. Riggs & Co.

The bonds referred to in the statements of assets were exhibited to us by the Treasurer, and consist of \$1,000 U. S. 4½s and \$500 4 per cent. bonds.

All of which is respectfully submitted.

JNO. JAY KNOX.

ROBERT FLETCHER.

G. K. GILBERT.

The report was adopted, and the committee discharged.

The President, Mr. TAYLOR, then offered a brief communication
ON THE TOTAL LUNAR ECLIPSE OF JUNE 11, 1881.

This was noteworthy for the bright illumination of the moon's disk, which occurred during totality. The features of the moon's surface could be seen almost as distinctly during total eclipse as during full moon. This phenomenon was attributed to the refraction caused by the earth's atmosphere. To an observer stationed upon the moon a bright circle of sunlight would be visible surrounding the earth, and to the light from this source was attributed the illumination of the moon's disk seen during total lunar eclipses.

This communication was discussed by Mr. HARKNESS.

Mr. DALL then presented a brief communication

ON SOME PECULIAR FEATURES OF MOLLUSKS FOUND
AT GREAT DEPTHS.

While considerable difficulty was experienced in separating some of the forms by their shells alone, yet, when their anatomy was examined, some very striking differences were presented. Among the dredgings off the Atlantic coast and in the Gulf of Mexico by the *Blake* were found mollusks claimed to be representatives of two new families having a dentition simulating that of the Docoglossa. One related to the Fissurellidæ and the other referable to the order Rhipidoglossa.

This communication was discussed by Messrs. GILL and ALVORD, after which the Society adjourned.

210TH MEETING.

JANUARY 28, 1882.

President WM. B. TAYLOR in the chair.

Thirty-nine members and visitors present.

Mr. FERREL presented to the Society a communication entitled

ON THE CONDITIONS DETERMINING TEMPERATURE,

but, from lack of time, did not complete its presentation, and asked for a continuance at some future meeting.

Mr. L. F. WARD then read a paper entitled

ON THE ORGANIC COMPOUNDS IN THEIR RELATIONS TO LIFE.

This paper was briefly discussed by Messrs. ANTISELL and ELLIOTT, after which the Society adjourned.

211TH MEETING.

FEBRUARY 11, 1882.

President WM. B. TAYLOR in the chair.

Mr. GILBERT presented to the Society a communication

ON ERRORS OF BAROMETRIC OBSERVATIONS PRODUCED BY WIND.

This communication will be published in full in the Report of the Geological Survey.

This communication was discussed by Messrs. BAKER, MASON, and ANTISELL, after which the Society adjourned.

212TH MEETING.

FEBRUARY 25, 1882.

President WM. B. TAYLOR in the chair.

Thirty members and visitors present.

Mr. FERREL presented to the Society the concluding portion of a communication offered to the Society at its 210th meeting, January 28th,

ON THE CONDITIONS DETERMINING TEMPERATURE.

The usual formula for the rate of cooling of a heated body in vacuo, first given by Pouillet as determined from the experiments of Dulong and Petit, is of the form :

$$\delta h = Bf(\mu^{\tau} - \mu^{\tau'})$$

In which

B = the units of heat radiated by a unit of lamp-black surface in a unit of time;

f = the radiating power of the body, lamp-black being unity;

τ = the temperature of the cooling body;

τ' = the temperature of the enclosure;

μ = a constant, of which the value is 1.0077;

δh = the heat lost in a unit of time for each unit of surface.

The first part of the second member, $Bf\mu^\tau$, expresses the amount of heat radiated by the body, and the second, $Bf\mu^{\tau'}$, the amount of heat received from the enclosure; the radiating and absorbing powers being usually assumed to be the same, f is common to both.

In applying this formula to bodies in space, protected from the rays of the sun, τ' would represent the temperature of space, by which is meant the temperature at which a body would stand by the heat received from the stars. In applying it to bodies on the earth's surface it may be regarded as the temperature of an imaginary enclosure, from which as much heat would be received as from all surrounding objects, the earth's surface, and the atmosphere, &c., not including the sun, and hence it represents the shade temperature.

If we now suppose the body to be exposed to the direct rays of the sun, the amount of heat thus received must be added to that received from space, or from terrestrial surroundings, that is, to $Bf\mu^{\tau'}$, and the preceding formula then becomes

$$(1) \quad \delta h = -K\rho f + Bf(\mu^\tau - \mu^{\tau'})$$

In which

K = the units of heat received from the sun on a unit of surface;
 ρ = the ratio between the surface receiving rays, projected on a plane perpendicular to the rays, and the whole radiating surface.

As the body receives the rays from one direction and upon one side only, and radiates from all sides, the average amount of heat, $K\rho f$, received over the whole surface and absorbed, must be compared with the amount lost by radiation, and hence the factor f must come in, since only the heat absorbed affects temperature, the absorbing and radiating power here, as usual, being assumed to be the same.

In the case of a spherical body, as the bulb of a thermometer, the value of ρ becomes $\frac{1}{4}$, since the projected receiving surface of the sphere is one-fourth of the whole radiating surface of the sphere. In the case of a long cylinder, in which the radiation from the ends could be neglected in comparison with the whole, the value of ρ becomes $\frac{1}{\pi}$, if the side of the cylinder is exposed perpendicularly to the sun's rays. In the case of a thin disk, with its surface perpendicular to the sun's rays, neglecting the radiation from the

edge, the value of ρ would be $\frac{1}{2}$. In the case of such a disk, in which the radiation is from one side only, which would be approximately so in the case of such a disk with the opposite side of polished silver, the value of ρ would be unity.

The amount of heat, K , received from the sun through the atmosphere at the earth's surface is usually expressed by

$$(2) \quad K = Ap^\epsilon$$

In which

A = the heat received from the sun on a unit of surface at the top of the atmosphere;

ϵ = the secant of the zenith distance of the sun;

p = a constant for all zenith distances, but differing in different states of the atmosphere, but always less than unity.

In the case of a static equilibrium of temperature, which was the only case considered, δh vanishes, and the preceding equations, (1) and (2), give

$$(3) \quad \rho Ap^\epsilon = B(\mu^\tau - \mu^{\tau'})$$

This equation expresses the condition which determines the static temperature, τ , of a body, and it is seen that this depends upon the solar constant A ; the form of the body, upon which the value of τ depends; upon the value of p , or the state of the atmosphere; upon the zenith distance, which determines ϵ ; upon the radiating constant, B ; and upon the shade temperature, τ' .

Putting for the unit of heat the amount required to raise the temperature of a cubic centimetre or gram of water one degree centigrade, and the square centimetre, second, and degree centigrade, for the units of surface, time, and temperature, respectively, the value of B was determined by the author, from the experiments of Mr. J. P. Nichol on the rate of cooling of a blackened copper ball in vacuum, surrounded by an enclosure of blackened surface, (Proc. Royal Soc. Edin., 1869-70, p. 207,) to be .01808. This value was considered more reliable than that of Pouillet from the experiments of Dulong and Petit, since the latter were made on the rate of cooling of mercury in a glass bulb, and the results had to be reduced to those which would have been obtained with a blackened surface; and the value of the radiating power, f , for glass, which was used in this reduction, Pouillet states, was somewhat hypothetical, and so it left some doubt with regard to the true value

of the constant. Pouillet's value of B for the minute-unit was 1.146, and this reduced to the second-unit is .01910. The value $\mu = 1.0077$ required no change to satisfy the results of Mr. Nichol's experiments.

The value of A , deduced from the experiments of Pouillet and Herschel with the actinometer, is .03046 for the mean distance of the sun, both sets of experiments, when reduced to the sun's mean distance, giving very nearly the same value. At the time of the earth's perihelion this is about one-thirtieth greater, and at aphelion as much less.

Pouillet's value of p for clear weather is about 0.75, but others make it considerably less. It can hardly be regarded as a constant, but only as a sort of average of values for clear weather, which may differ very much at different times. According to Tyndal, who maintains that the absorption power of the atmosphere in clear weather depends almost entirely upon the amount of aqueous vapor in it, the value of this constant, even in clear weather, must depend very much upon the hygrometric state of the atmosphere.

With the preceding numerical values of the constants of A and B , the preceding equation gives

$$(4) \quad \mu^{\tau - \tau'} = \frac{1.685 \rho p^e}{\mu^{\tau'}} + 1$$

for determining the value of $\tau - \tau'$, for any zenith distance of the sun, of which the secant is ϵ , where the value of p and the shade temperature τ' are known. But since the value of B was determined for a vacuum, this formula is only applicable where the radiating body is in a vacuum, and cannot be applied in cases where the body receives or loses heat by conduction or convection.

The first term of the second number of the preceding equation depends upon K , the heat received from the sun, and, therefore, vanishes where the body is in the shade, and we then have $\tau - \tau' = 0$. Hence the temperature of all bodies having the same surroundings must cool down to the same temperature, τ' . This is a necessary consequence of the equality of the absorbing and radiating powers of bodies.

The author had been able to find but few observations of the value of $\tau - \tau'$ to compare with the theoretical value given by the preceding formula. Hooker states that from a multitude of desultory observations made on the Himalaya Mountains at an eleva-

tion of 7,400 feet, he concluded that the average effect of the sun's rays on a black-bulb thermometer was 125.7° or 67° (37.2° C.) above the temperature of the air. The shade temperature was, therefore, 14.8° C. With this value of τ' , and the value $\rho = \frac{1}{4}$ for the spherical bulb, we get $\tau - \tau' = 41.6^{\circ}$ at the top of the atmosphere where $p = 1$. The value of p for that altitude, and also the value of ε for the observations, are not accurately known. At the elevation of 7,400 feet, Pouillet's value of $p = .75$ would have to be considerably increased, but the effect of the exponent ε would perhaps bring the value of p^{ε} equal to about .75. With this value of p^{ε} the formula gives $\tau - \tau' = 32.4^{\circ}$, five degrees too small for the observed value.

Again, at the height of 13,100 feet, he found in January, at 9 a. m., the temperature of the black bulb 98° with a difference of 68.2° , and at 10 a. m., 114° with a difference of 81.4° . From the average of these we get $\tau' = -0.4^{\circ}$ C. and $\tau - \tau' = 41.6^{\circ}$ C. The preceding formula gives $\tau - \tau' = 45.7^{\circ}$ C. at the top of the atmosphere where $p = 1$. At the elevation of 13,100 feet the value of p^{ε} should not be very much less than unity—perhaps about as much less as would reduce the theoretical value 45.7° down to the observed value 41.6° .

It should be remarked here that the theory requires that the two thermometers should have exactly the same surroundings. If the one thermometer is in a vacuum surrounded by a glass bulb and the other outside, this condition is not perfectly fulfilled, and the indication of the thermometer outside in the shade might vary a little from one in the shade within the bulb, unless this bulb is so situated as to have the same temperature as the external shade thermometer.

If, in place of a black-bulb thermometer, we had a thin disk with a blackened side exposed perpendicularly to the sun's rays, and the opposite side of polished silver of which the radiating power is extremely small, we should have in this case the value of $\rho = 1$ very nearly, and with this value of ρ the formula would give, in the first of the examples above, for the top of the atmosphere, $\tau - \tau' = 106.6^{\circ}$ C., which, added to the shade temperature, 14.8° , would give $\tau = 121.4^{\circ}$ C. This enormously high temperature is not inconsistent with observation, for water has been made to boil from the effect of the direct rays of the sun at the earth's surface,

where the theoretical condition of our formula, that no heat shall be lost by conduction, was not perfectly fulfilled.

A portion of the earth's surface, where the soil is dry and sandy, having little conductivity for heat and exposed to the vertical rays of the sun, would be a case similar to that of an isolated disk radiating sensibly from one side only, and the temperature of such a surface, so exposed, should stand at a very high temperature, but of course not nearly up to the theoretical temperature, since much heat would be conveyed away by the conduction and convection of the air, and also some conducted down into the earth. The temperature of sandy soils is often observed to be as high as 150° F. and upwards, and the preceding theory explains these very high temperatures and the great differences of temperature of different bodies under the same circumstances.

From equations (2). and (3), with the given values of A and B , we get

$$(5) \quad K = .07232 \mu^{\tau'} (\mu^{\tau} - \tau' - 1)$$

This is an actinometric formula, giving the amount of heat received from the sun, in absolute heat units, from the observation of the sunshine and shade temperatures. So far as the author's reading extends no such formula has ever been given, but $\tau - \tau'$ has been regarded as a measure of the sun's relative intensity under different circumstances. The formula not only gives the absolute instead of the relative amount of heat received, but it shows that $\tau - \tau'$ is not proportional to K , and consequently not a correct measure of the relative intensities of the sun's rays. With an observed value $\tau - \tau' = 35^{\circ}$ and $\tau' = 30^{\circ}$ the formula gives $K = .02806$; but with the same value of $\tau - \tau'$, and with the value of $\tau' = 0^{\circ}$, it gives $K = .02229$. Hence the value of K is not proportional to $\tau - \tau'$, and differs considerably when the value of $\tau - \tau'$, under different circumstances, is the same. Both these values of K are less than the value of $A = .03046$, as they should be by equation (2). The greater the altitude the more nearly should the value of p approximate to that of unity, and the more nearly should the value of K approximate to that of A .

If the value of p , according to Tyndal, as has been stated, depends upon the hygrometric state of the atmosphere, then the value of K , as given by the preceding formula, for any observed values of τ and τ' , must give the diathermancy, and consequently the

hygrometric state of the atmosphere in clear weather, not only for the point of observation, but generally throughout the whole extent of the atmosphere through which the rays pass, for the greater the value of K the greater the diathermanancy of the air, and hence the less the amount of aqueous vapor in it.

This was briefly discussed by Messrs. HARKNESS, H. FARQUHAR, and TAYLOR.

Mr. ANTISELL then began the presentation of a communication

ON THE BUILDING UP OF ORGANIC MATTER,

which was unfinished when the hour of adjournment arrived, and its completion went over to the next meeting.

213TH MEETING.

MARCH 11, 1882.

President WM. B. TAYLOR in the chair.

Thirty-seven members and visitors present.

Mr. ANTISELL then presented to the Society the remainder of his communication

ON THE BUILDING UP OF ORGANIC MATTER,

the presentation of which was begun at the last meeting.

A brief discussion of this paper—the session having been prolonged for this purpose—followed, and was taken part in by Messrs. GILL and WARD, who took exceptions to some of the conclusions arrived at in the communication.

214TH MEETING.

MARCH 25, 1882.

President WM. B. TAYLOR in the chair.

Thirty-six members and visitors present.

The President announced to the Society the death, at 3 p. m. this day, of pneumonia, after an illness of two days, of Mrs. Joseph Henry, widow of the first president of the Society.

Mr. A. B. JOHNSON then presented to the Society a communication

ON SOME PECULIAR RAVAGES OF TEREDO NAVALIS.

This communication was discussed by Messrs. ANTISELL, DALL, GILL, HARKNESS, and WHITE.

Mr. ANTISELL called attention to the fact that the existence of the *Teredo*, as well as that of other destructive mollusks brought to our harbors by shipping, along our entire coast is well known, and that, in view of this fact, it is a matter of surprise that provision was not made for guarding against this danger. To this it was answered by Mr. Johnson that the wharf was a temporary one, being only needed for three months, and that, although the presence and destructive powers of the *Teredo* were recognized by the Board, it did not appear that in any previous case the destructive action of the *Teredo* was so rapid as to render special precaution necessary in this case. Upon a question from Mr. Harkness it was asserted by Mr. Johnson that a pile, examined on September 15 by divers, and found sound—chips cut by divers from the pile under water were found unbored by the *Teredo*—broke down on September 19, thus indicating a destruction of a pile in four days.

The accuracy of the observation of September 15, that the chips were unbored, was questioned by Mr. Dall, who asserted that the *Teredo* in its youngest stage attacks the wood, and that the hole made is at first very minute, and is gradually enlarged and deepened as the mollusk grows. So that a pile which appears sound on the surface may, in fact, already be seriously injured by *Teredo* borings. In San Francisco Bay the work of destruction of piles by the *Teredo*, and their renewal goes on continually, and it is estimated that a complete renewal of all the piles in the bay occurs every seven years. The mollusk works and breeds the year round in waters above a temperature of 60° F. It attacks the hard woods, as *lignum vitæ*, quite as readily as softer woods, but the destruction in such case is less rapid. Such woods, however, as palmetto, consisting of bundles of tough fibres interspersed with soft or spongy material, are only slightly, if at all, injured.

Mr. GILL called attention to the fact that the Dutch Commissioners, appointed in consequence of the great ravages of the *Teredo* on the coast of Holland in about 1859, found creosote the best pre-

ventive. They further found that the activity of the Teredo was, to a certain extent, dependent upon meteorological conditions since the years 1720, 1755, 1782, 1820, and 1850, were seasons of great drought, and consequent increase of salinity of the sea-water along the coast, and in those years the destruction caused by the Teredo was unusually great.

Respecting the geological age of the Teredo, Mr. WHITE exhibited to the Society fossilized wood from the cretaceous formation showing Teredo borings.

Mr. BILLINGS then presented to the Society a communication

ON THE VENTILATION OF THE HOUSE OF REPRESENTATIVES, which was unfinished when the hour of adjournment arrived, and went over to the next meeting.

Adjourned.

215TH MEETING.

APRIL 8, 1882.

President WM. B. TAYLOR in the Chair.

Forty-eight members and visitors present.

Mr. BILLINGS then continued the presentation of the communication begun at the last meeting

ON THE VENTILATION OF THE HOUSE OF REPRESENTATIVES, of which the following is an abstract:

The difficulties to be overcome, and the means used for this purpose were explained, and plans and sections of the Hall of the House of Representatives at the Capitol, in Washington, were shown. The amount of fresh air required is about one foot per second per person, if an approach to perfect ventilation is desired. The imperfect form of ventilation by dilution requires from forty to fifty feet per minute. When a hall is occupied only one or two hours, the cubic space is important, but in long sessions it is the supply rather than the space that must be looked to.

To produce the requisite movement of the large amount of air used, special force must be supplied. This may be propulsion—the plenum method, or by aspiration—the vacuum method, or a combination of the two. The effect of wind and rain on aspirating

systems was alluded to. In the majority of such halls the plenum system, by means of a fan, is used. The difficulty in introducing this large amount of air into a hall depends partly on the necessity for avoiding unpleasant currents, and partly on the cost of heating and supplying power. The question of cost, however, in such halls as are referred to, is usually a minor consideration, but if the tastes of individuals as to temperature are to be consulted—that is, if each man is to have his air at the temperature which suits himself—the cost becomes a serious matter.

The effects of various positions of fresh air inlets were pointed out, and stated to depend largely upon the tendency of air to adhere to surfaces over which it passes, as shown by the investigations of Savart and others. The difference between the upward and downward system were pointed out.

The various modes of heating were described, more especially with reference to their effect upon the air, and the influence of moisture was discussed. Probably the importance of moistening the air is less than has been supposed, and the methods employed for this purpose have been beneficial only indirectly.

The system of heating and ventilation of the Hall of the House was then described, and compared with that of the English Houses of Parliament, the Chamber of Deputies at Versailles, and the Grand Opera House at Vienna, and Frankfort on Main.

The great importance of skilled superintendence was pointed out, and the necessity for continuous records was insisted on.

Remarks upon this communication were made by Messrs. ANTISELL, ELLIOTT, MUSSEY, and POWELL.

Mr. HILGARD then presented a communication
ON SIEMENS' DEEP SEA THERMOMETER AND CARRÉ'S ICE MACHINE.

Remarks on this communication were made by Messrs. ANTISELL, DALL, DUTTON, and E. J. FARQUHAR, after which the Society adjourned.

216TH MEETING.

APRIL 22, 1882.

President WM. B. TAYLOR in the chair.

Thirty-six members and visitors present.

The Secretary read a list of names of persons who had been

elected to, and had accepted membership in, the Philosophical Society, viz: EZRA WESTCOTT CLARK, HENRY FLAGG FRENCH, HENRY ALLEN HAZEN, CHARLES HUGO KUMMEL, ISRAEL COOK RUSSELL, WILLIAM WIRT UPTON, ALBERT LOWRY WEBSTER.

Mr. FERREL then presented to the Society a communication

ON SOLAR RADIATION AT SHERMAN, WYOMING.

The next communication was by Mr. C. A. WHITE

ON ARTESIAN WELLS ON THE GREAT PLAINS.

This communication has been essentially reproduced with the title, "Artesian Wells upon the Great Plains," (subscribed C. A. White,) in the American Review for August, 1882, No. 135, pp. 187-196.

Mr. ANTISELL called attention to previous attempts on the part of the Government to obtain water on the great plains by boring artesian wells. During the surveys and explorations of the 39th parallel, for the purpose of ascertaining the feasibility of building a railroad to the Pacific Ocean, special attention was given to the matter of obtaining water by means of artesian wells, and at that time he reached the same conclusion essentially as that now presented by Mr. White. Mr Antisell's published report upon this subject may be found in volume 7 of the Pacific Railroad Reports published in 1854.

Mr. MUSSEY called attention to boring now in progress along the line of the Southern Pacific Railroad in New Mexico; boring being in progress at the expense of the railroad company for the purpose of supplying water for locomotive purposes.

Mr. GILBERT considered the argument conclusive as to the failure of artesian wells on the great plains to be of any practical value for irrigating purposes, but for some other uses, such as stock raising, farm uses, etc. Some wells in favorable localities had proved a success, and others would also undoubtedly prove successful. Geological prophecy is generally, however, to be made with great caution, and to be received with caution equally great, a proposition which was supported by citing several cases in the experience of himself and others.

On the close of this discussion Mr. ELLIOTT presented a communication

ON THE CREDIT OF THE UNITED STATES, PAST, PRESENT AND PROSPECTIVE.

This communication will be published in another form.

Remarks upon this paper were made by Messrs. GILL and W. B. TAYLOR, after which the Society adjourned.

217TH MEETING.

MAY 6, 1882.

President WM. B. TAYLOR in the chair.

Twenty-eight members and visitors.

The President announced to the Society the death of two of its members, Mr. WILLIAM J. TWINING, Major U. S. Engineers and Commissioner of the District of Columbia, and Mr. JOHN RODGERS, Senior Rear Admiral U. S. Navy and Superintendent U. S. Naval Observatory. He further announced to the Society that the proposition for a federation of the Anthropological, Biological, and Philosophical Societies had been discussed by the General Committee, but that thus far no action had been taken.

The first communication was by Mr. ELLIOTT COUES,

ON THE POSSIBILITIES OF PROTOPLASM.

The following is an abstract of this communication, which has been published at greater length under the title—"Biogen: a Speculation on the Origin and Nature of Life. Abridged from a paper on the 'Possibilities of Protoplasm,' read before the Philosophical Society of Washington, May 6th, 1882. By Dr. ELLIOTT COUES. Washington: Judd & Detweiler, printers and publishers. 1882." (8vo., pp. 27.)

Referring to previous papers on the subject of Life, by Mr. WOODWARD and Mr. WARD, the speaker opposed any purely chemico-physical theory, and adhered to the doctrine of the actual existence of a "vital principle." Granting that all substances, including protoplasm, have been evolved from nebulous matter; that evolution to the protoplasmic state is necessary for any manifestation of life, and even that life necessarily appears in matter

thus elaborated, it does not follow that the result of the processes by which matter is fitted to receive life is the *cause* of the vitality manifested. For all that is known to the contrary protoplasm and vitality are simply concomitant; or if there is any causal relation between them, vital force is the cause of the peculiar properties of protoplasm, not the result of those properties. There really exists a potency or principle called "vital," in virtue of which the chemical substance called protoplasm manifests vitality, that is to say, *is alive*, and in the absence of which no protoplasmic or other molecular aggregation of matter can be alive. The chemico-physical theory simply restates abiogenesis or "spontaneous generation," of which we know nothing scientifically. The grave doubt that "life is a property of protoplasm" will persistently intrude until some one shows what is the chemico-physical difference between living and dead protoplasm; none being known.

Noting that chemistry and physics had combined to manufacture an egg which would do everything to be expected of an egg, except to hatch, the speaker summed his charge thus: The atheistic physicist, denying mind in nature, declares that matter alone exists. Matter in motion is all there is; the cosmos being matter in motion in virtue of material forces alone. This is simply to invent a kind of perpetual motion machine, and leave out even the inventor; for such a machine invented itself and set itself going. Then the materialistic chemist takes this self-started machine and declares it has laid an egg that will hatch. On any such theory a God is not only superfluous but impossible. Yet the result of the alleged self-evolution of self-created matter through chemical elements to organic compounds has been the creation of a protoplasmic soul so constituted that it must believe in a God; and if matter be that God, matter contradicts itself, for the constitution of the human soul requires that its God must be other than its protoplasmic self; while if matter be not that God, there must be some other.

The speaker argued for the existence of the soul as something apart from and unlike matter, defining "soul" as that quantity of spirit which any living body may or does possess. No idea can attach to the term "spirit" from which all conceptions of matter are not absolutely excluded. Spirit is immaterial, self-conscious force; life consists in the animation of matter by spirit.

The substance of mind and the substance of matter were noted as equally hypothetical. To the former was given the name

Biogen, or "soul-stuff," and it was defined as spirit in combination with the minimum of matter necessary to its manifestation. The analogy between biogen and luminiferous æther, or the hypothetical substance of light, was discussed. The drift of the speaker's speculation on the vital principle as an *ens realissimum* was toward a restatement, in scientific terms, of the old *anima mundi* theory. Modern materialistic and atheistic notions about life were denounced as every one of them disguises of the monstrously absurd statement that a self-created atom of matter could lay an egg that would hatch.

The whole matter being beyond the scrutiny of the physical senses is remote from the scope of exact science; but it is irrational and unscientific to deny it, as is virtually done when science excludes it from any share in life-phenomena, by presuming to explain life upon purely material considerations. No chemico-physical theory of life is tenable that does not satisfactorily explain the chemico-physical difference between, for example, a live amoeba and a dead one; an explanation which has never yet been, and probably cannot be, given.

A general discussion of the points involved in this paper followed. Mr. POWELL pointed out what he regarded as a fundamental and fatal error in the reasoning, viz., that the axiom that the whole equals the sum of all its parts, had been assumed throughout to be true *qualitatively* as well as *quantitatively*. Furthermore, he maintained that logical consistency required that those who believe in force should believe also in the vital principle, and *vice versa*. As for himself, however, there was neither force nor vital principle, but only matter in motion. Three relations are always to be borne in mind, viz., quantity, quality, and succession, whereas the physicist falls into error by considering only the quantitative relation.

So much of the support of the views of Mr. Coues as might be derived from the common consensus of mankind was criticised by Mr. Gill as unsound, since the common consensus of mankind has often been found at fault; the supposed flatness of the earth, the motion of the sun around the earth, etc., are examples where this criterion fails. Paraphrasing an eminent philosopher's dictum, he thought there was a tendency of biologists ignorant of philosophy and philosophers ignorant of biology to make a distinction between organic and inorganic matter, and call in a "vital force." He likened

living and dead protoplasm to an electric battery in action and at rest, and maintained that life is a property of matter, and that it cannot be conceived of separated from matter.

Mr. HARKNESS avowed his belief in force, and hence in vital force, and further in a little religion, and was, therefore, moved to make inquiry concerning the chemical difference between living and dead matter.

Mr. WARD pointed out that very diverse views were held upon this subject by two classes of thinkers who do not come into intellectual contact. Furthermore, while not asserting that a belief in vital force was a superstition, attention was drawn to the fact that infantile races attribute all phenomena to supernatural agencies, and that, with increasing knowledge, there is a decrease in the number of these appeals to supernatural agencies.

The corner stone of modern science, said Mr. DOOLITTLE, is *measure*. We must have a biometer. What electrical science would be without ohms, astronomy without graduated circles, chemistry without the balance, such is biology without a *measure*. Is there more life in two mice than in one mouse? In a horse than in a mouse? Until we can answer these questions substantial progress in biology is not to be expected.

The term automatic, as used here, he considered a confession of biologic ignorance. Automatic motion, as used in the discussion, seemed to mean simply motion which cannot be relegated to any known law.

After some further desultory discussion the Society adjourned.

218TH MEETING.

MAY 20, 1882.

President WM. B. TAYLOR in the chair.

Thirty-two members and visitors present.

A series of resolutions concerning the death of Admiral JOHN RODGERS, a member of this Society, which resolutions had been adopted by the General Committee, were read by the Secretary; after which Prof. CHARLES W. SHIELDS, of Princeton College, read to the Society a communication

ON THE PHILOSOPHICAL ORDER OF THE SCIENCES.

This communication has been published by Scribner's Sons in a

volume entitled "The Order of the Sciences. An Essay on the Philosophical Classification and Organization of Human Knowledge." By Charles W. Shields, Professor in Princeton College. 103 pp., 12mo. New York, Charles Scribner's Sons, 1882.

This communication was discussed by Messrs. WARD, POWELL, ANTISELL, TAYLOR, ALVORD, and BAKER.

219TH MEETING.

JUNE 3, 1882.

President WM. B. TAYLOR in the chair.

Twenty-two members and visitors present.

The first communication offered was by Mr. ALVORD

ON THE COMPASS PLANT.

This communication has been published with the title "On the Compass Plant," by Benjamin Alvord, in the American Naturalist for August, 1882, No. 16, pp. 625-635.

Remarks were made on the exhibition of polarity in other vegetable types by Messrs. HENRY FARQUHAR and THEODORE GILL.

Mr. E. B. ELLIOTT next presented to the Society a communication

ON SOME FORMULÆ RELATING TO GOVERNMENT SECURITIES.

Mr. C. H. KUMMELL then presented a communication

ON COMPOSITION OF ERROR FROM SINGLE CAUSES OF ERROR.

This was unfinished when the hour of adjournment arrived, and its completion went over to the next meeting.

Adjourned.

220TH MEETING.

JUNE 17, 1882.

President WM. B. TAYLOR in the chair.

Twenty-three members and visitors present.

Mr. C. H. KUMMELL continued his communication

ON COMPOSITION OF ERROR FROM SINGLE CAUSES OF ERROR.

which was begun at the last meeting.

This paper is expected to appear in full in the *Astronomische Nachrichten*.

Remarks upon this paper were made by Messrs. E. B. ELLIOTT and W. B. TAYLOR.

Mr. MARCUS BAKER then presented the following communication

ON A GEOMETRICAL QUESTION RELATING TO SPHERES.

On January 17, 1882, Mr. Doolittle called the attention of the Society to the geometrical problem *To determine a circle equally distant from four given points in a plane*, and showed that the statement in Chauvenet's *Geometry*, (p. 308, Ex. 110,) that this problem admits of *four* solutions is erroneous, there being in general *fourteen* solutions. The extension of this problem to spheres and five points in space is nearly as simple as for the case of circles and four points in a plane.

Let it be proposed to solve the following :

PROBLEM.—*To determine a sphere equally distant from five given points.*

The distance to a sphere, considered here, is to be measured along a diameter, produced if necessary, and hence for any position we have two distances, one a maximum, the other a minimum.

Solution.—Case I. Through any four of five given points, a, b, c, d, e , as, for example, b, c, d, e , describe a sphere; the fifth point, a , will in general fall within or without this sphere, of which call the radius R and centre C ; also, let α be the distance from the centre of this sphere to the point a . Then two spheres described with centre C and radii $\frac{1}{2}(R \pm \alpha)$ fulfil the condition of being equidistant from the five points.

Every distinct group of four of the five given points in like manner gives two solutions; hence of this kind there are in all *ten* solutions.

Case II. Through any three of the five given points, a, b, c, d, e , as a, b, c , pass the circumference of a circle; from the centre of the circle erect a perpendicular. This perpendicular is the locus of all points equidistant from points a, b, c . Join the points d and e by a line; bisect this line by a plane perpendicular thereto. This plane is the locus of all points equidistant from d and e . The intersection of these two loci is the centre of two spheres equidistant from the five points.

Every distinct group of three of the five given points in like manner gives two solutions; hence of this kind there are in all *twenty* solutions.

Therefore, in general there are *thirty* spheres equally distant from five given points.

The next communication was by Mr. H. A. HAZEN

ON THE RETARDATION OF STORM CENTRES AT ELEVATED STATIONS, AND HIGH WIND AS A PROBABLE CAUSE.

In the absence of Mr. Hazen the following abstract was read by the Secretary, Mr. Baker:

In his tenth paper, published in the January, 1879, number of the American Journal of Science, Prof. Elias Loomis advanced certain evidence, based on barometric observations, to show that apparently the progress of a storm centre was much more rapid at the surface of the earth than at elevations above it. It is the purpose of this article to put forth certain facts which, it is hoped, will tend to elucidate the subject.

Not long since, before this Society, Prof. G. K. Gilbert showed that a high wind had a tendency to depress the barometer column, as determined from his discussion of certain observations made by the Signal Service at the summit and along the side of Mount Washington, New Hampshire. If now a wind can produce such a depression, it would seem as if the wind accompanying a storm and continuing its force at a high station some time after the passage of the storm centre at the base, might cause the apparent retardation.

It is very desirable that special experiments be made, under natural conditions, directly testing the influence of high winds on the barometer column.*

It seems possible to indirectly ascertain such influence from a barometric computation of the height of a mountain by means of observations taken during different wind velocities. Table I gives such a computation of the height of Mount Washington from observations at the base and summit in May, 1872 and 1873.

*Direct experiments have been made, using a blower for the air current, and an air-tight receiver for the barometer, at short distances, a condition of things, however, which can never occur in nature.

TABLE I.

Mean amount to be added to the true difference of elevation between the summit and base of Mount Washington in order to give the computed difference, arranged according to the force of the wind.

	WIND FORCE IN MILES PER HOUR.													
	0 to 10.		11 to 20.		21 to 30.		31 to 40.		41 to 50.		51 to 60.		Above 61.	
	Cases.	Am't.	C.	A.	C.	A.	C.	A.	C.	A.	C.	A.	C.	A.
May, 1872	77	—27.1	25	—18.6	30	—3.1	43	+13.8	65	+10.5	32	+33.9	50	+51.4
May, 1873	104	—43.5	134	—22.0	183	+4.1	135	+15.6	99	+34.9	61	+52.4	27	+80.1

In the above table, for May, 1872, all winds under 10 and above 40 are included, and in May, 1873, all the cases, except a few which were omitted because of serious errors in the observations.

The table shows this remarkable peculiarity that, though with winds above sixty-one miles per hour, the mean computed difference in height is too great by sixty-six feet; with winds under ten miles per hour the mean difference is too small by thirty-five feet. We conclude, then, that some other cause must produce the results, or must act in conjunction with the wind. Taking the wind above sixty-one miles per hour I have found ten cases in which the height was too small by about fifteen feet, also a great number of cases in which, though the wind continued strong from the same direction, yet the computed height continually became less, showing that the wind does not produce a direct effect upon the indications of the barometer. On projecting the curves of pressure we find that there is a uniformity in the occurrence of small and large differences of elevation with the maxima and minima of pressure, the least being found when the pressure is high, and the greatest when it is low.

Grouping a second time, then, with respect to the maxima and minima of pressure, we have Table II.

TABLE II.

Mean amounts to be added to the true difference of height between the summit and base of Mount Washington to obtain the computed difference.

DATE.	LOCALITY.	MAXIMA OF PRESSURE.		MINIMA OF PRESSURE.	
		Cases.	Amount.	Cases.	Amount.
May, 1872 -----	Mt. W. and base----	81	— 32.5	70	+ 57.4
May, 1873 -----	Mt. W. and base----	102	— 61.6	137	+ 67.3
Jan., Feb., Mar., Oct., Nov., Dec., 1880.	Mt. W. and mean of B. and P.	119	— 29.1	120	+ 127.0

As the first two horizontal rows of figures apply only to observations for the month of May, and as it would be very desirable to have results for the colder months when the fluctuations are much increased, I have added a third set of figures for the summit of Mount Washington, compared with the mean of Burlington and Portland as the base, and computed the difference of elevation from observations taken at 7 a. m., 3 p. m., and 11 p. m., Washington time, during January, February, March, October, November, and December, 1880.

It is evident from Table II that during the prevalence of relatively high pressure, elevations computed barometrically will, in general, be too small, and, on the other hand, when the pressure is low, the computed heights will be too great. This also explains the coincidence of too great computed heights with high winds, for the reason that the highest winds always occur with relatively low pressure; on the contrary, when the wind is light, the pressure is generally high.

May not this retardation be due to the effect of varying temperature? When a "low" has passed a station at sea level the temperature frequently falls steadily, thus contracting the atmosphere and causing its withdrawal from the upper regions, and a still further fall in pressure there. This process will continue until the fall caused by the low temperature is counterbalanced by the rise due to the advancing "high." The following is given as an illustration :

Observations of air-pressure and temperature at Denver and Pike's Peak, Colorado, in November, 1880.

Day.	Hour. Wash. Time.	Temp. Pike's Peak.	Mean Temp. Pike's Peak and Denver.	PRESSURE.	
				Pike's Peak.	Denver.
		°	°	//	//
14	7 a. m.	— 5	6	17.75	24.69
	3 p. m.	+ 2	20	17.75	24.64
	11 p. m.	6	19	17.82	24.59
15	7 a. m.	10	22	17.83	24.50
	3 p. m.	14	34	17.71	24.28
	11 p. m.	11	16	17.57	24.48
16	7 a. m.	1	6	17.28	24.41
	3 p. m.	— 6	1	17.18	24.44
	11 p. m.	— 14	— 6	17.22	24.58
17	7 a. m.	— 31	— 20	17.13	24.54
	3 p. m.	— 19	— 10	17.25	24.49
	11 p. m.	— 16	— 12	17.42	24.42
18	7 a. m.	— 9	— 6	17.48	24.33
	3 p. m.	— 4	7	17.41	24.23
	11 p. m.	— 5	6	17.32	24.08

From these observations we see that, although the air-pressure was at a minimum at Denver, November 15, 3 p. m., yet, owing to the extraordinary cold, the pressure continued to fall at Pike's Peak, (which is 8,840 feet above Denver,) and did not reach its lowest point until forty hours afterward, or November 17, 7 a. m. Extending the same reasoning to the diurnal range of air-pressure we shall find a satisfactory solution of the retardation. From hourly observations at the summit and base of Mount Washington I find that while the morning maximum occurs at 8:30 a. m. at the base, it does not occur till noon at the summit, during this part of the day the temperature is rising rapidly; and hence we may suppose that it produces the continued rise in air-pressure at the summit overbalancing the diurnal range; in like manner the afternoon minimum occurs at 6 p. m. at the summit, or two hours later than at the base, as the temperature begins falling at 2 p. m. This may account for the difference at the two stations. On comparing

the night maximum and morning minimum I find little or no retardation; this is what we might expect from the fact that at this time there is little or no change in temperature.

The President, Mr. TAYLOR, called the attention of the Society to the remarkable halo witnessed by many people in Washington last Thursday, June 15, saying that in some respects it was remarkable, and presented some theoretical difficulties. While it had been seen by a number of those present, none had made any scientific observations of it or taken any measurements. A number of other halos were mentioned which, like this, occurred between 10 and 11 a. m., and it was thought worth while to consider whether halos appeared oftener at those hours than at others, and if so, why.

221ST MEETING.

OCTOBER 7, 1882.

The President in the chair.

Forty-one members present.

The consideration of the minutes of the last meeting was postponed.

The PRESIDENT welcomed the members to a renewal of the meetings of the Society after the summer vacation.

He also announced that vacancies had been created in the Committee by the resignation of Dr. J. J. Woodward, a Vice-President of the Society, on account of prolonged illness, and of Mr. Marcus Baker, one of the Secretaries, by reason of assignment to duty in California. The General Committee had elected Mr. E. B. Elliott a vice-president in place of Dr. Woodward, and Dr. J. S. Billings a secretary in place of Mr. Baker. The vacancies resulting therefrom in the membership of the Committee had been supplied by the election of Dr. D. L. Huntington, U. S. A., and Prof. C. V. Riley.

Mr. A. S. CHRISTIE made a communication

ON A SYSTEM OF STANDARD TIME.

A prime meridian (say Greenwich) time would, in general, give the hours of the local natural day dissymmetrical with respect to

the zenith of the clock face and the zero point of the hour numbers. Turning the dial plate until the prime meridian hour of local mean noon comes to the zenith, eliminates the first mentioned element of dissymmetry, and is a partial adaptation of prime meridian time to local convenience. The second element of dissymmetry is inherent in the nature of numbers, and cannot be eliminated whilst they are retained; for symmetry demands that the zero point shall be either *everywhere* or *nowhere*, neither of which conditions can be satisfied by the symbols now in use. Rejecting them, therefore, and adopting a series of hour symbols having no absolute numerical, but only an ordinal, significance, is another and final step in the adaptation of prime meridian time (such only as to the hour-zero) to general use.

A consideration of what symbols to adopt will immediately suggest, that an abandonment of the artificial, and a return to the simplicity of nature, constitutes the real and complete solution of the problem. That problem may now be stated: To avoid the discordance of local time on different meridians (a discordance which cannot be removed) by the adoption of the same standard time on all meridians, so that the hour and fraction of the hour shall be the same at the same instant everywhere; which standard time shall be marred by no dissymmetry with respect to the globe, alien in no land, essentially local everywhere, cosmopolitan and impartial as the sun himself.

The mere statement of the problem is almost sufficient. The system of time must consist in simply telling *where the sun is* with respect to our terrestrial meridians—the answer in every case must be the same in all quarters of the globe. To limit the geographical knowledge necessary, insure uniformity, and afford hour-zeros, twenty-four equi-distant meridians should be agreed upon as such hour zeros, and named from some country through which, or city near which, they pass. Regard now the dial plate of the clock as the earth, the north pole at center, and meridians, twenty-four of which are actually drawn, radiating to the circumference. (Mr. Henry Farquhar suggests that the dial plate be an actual planisphere.) Bring the local meridian to the zenith and let the hour-hand, revolving once each day, point to the mean sun. The time read from such a chronometer will be the natural, or sun time, proposed in this paper. Space here forbids details with respect to the theory itself, or mention of the objections urged against its

practicability; but it may be said in conclusion, in answer to an objection raised by Prof. Coffin, that the longitude of any place is given at once by the clock face at meridian transit of the mean sun, without any subtraction whatever.

Mr. HENRY FARQUHAR urged some objections to the device of reckoning time by meridians an hour apart, as not being sufficiently local to avoid a longitude correction in tables of sunrise and other astronomical events, nor sufficiently universal to escape confusion at points nearly 30 minutes from the standard meridians. He thought the need of a universal standard time, already greatly increased by railway and telegraph communication, would become still more strongly felt in the future. Inconvenience resulting from the occurrence of the 24th hour during daylight at any place, could be obviated by numbering hours beyond 24 and retaining the same day. It would not be suitable to reckon time everywhere from Greenwich midnight, since that would involve a change of day at local 10 A. M. in Sydney, (nearly noon in New Zealand) or, if the hours after 10 A. M. were counted as 25, 26, etc. of the previous day, a discrepancy in date between Australia and Europe. Hours might be reckoned from midnight at 6h. east of Greenwich, noon at 6h. west; though 5½h. west, a meridian passing near Cumberland, Maryland, would be preferable. The longitude of a place would be the time of mean noon at that place, and count from the last-named meridian westward, from 6h. to 30h., and not from 0h. to 24h. The longitude of Washington, then, would be 23h. 53.2m., that of San Francisco, 26h. 54.6m., Honolulu, 29h. 16.4m., Auckland, 7h. 5.7m., Calcutta, 12h. 51.7m., and Greenwich, 18h. 45.0m. The 6h. meridian would pass through Bering Straits and be the line adopted for the change of date.

East of British India the day would be understood to change at 24h., which hour would arrive at some time less than 6h. after midnight. For the rest of the world, the hours would run above 24, and be diminished by 24 at the time indicated by local custom and convenience for a change of day. In Washington, for example, the conventional day might change at 36h., the hours of next day counting on from 12h., or at 39h. and count on from 15h., according as it was preferred to have the change near midnight or about 3h. after midnight. At Greenwich the hour nearest midnight would be 31h. or 7h.

Mr. Farquhar also showed a proposed form of clock-face, in which the hours were numbered from 0 to 42 in two circuits, 24 being opposite 0, and so on. Such a clock would do for all meridians, but might easily be arranged to have any desired noon-time at the top.

Mr. COFFIN remarked that he had failed to appreciate the importance of standard time to the extent to which it had been frequently advocated. If we examine the several departments, in which such time is supposed to be needed, we can better determine in what way a requirement of that kind can be best supplied.

In navigation the time of the prime meridian is a necessity; and this is furnished directly by chronometers regulated to that time, while from astronomical observations the corresponding local time may be found; and both are involved in all questions of longitude. No further standard time is needed in this department.

The use of an astronomical ephemeris also requires the time of the meridian for which it is prepared. A prime meridian common to all nations is a desideratum. But at present the maritime nations of Great Britain and the United States reckon longitudes from Greenwich, while on some of the nautical charts of Russia, Germany, and Spain, longitudes are given from Greenwich as well as from the prime meridian of each respective country. Besides this use of the meridian of Greenwich more general than of any other meridian, the meridian of 180° E. or W. from Greenwich passes near Behring Strait and through an extensive unoccupied region of the Pacific Ocean, where it will be most convenient to have the change of day, which is one less on the east side of such meridian than on the west. Indeed, the change of longitude from east to west, or the reverse, necessarily requires a change of the local day. *Where* the change is made, is arbitrary. For instance, the longitude 175° E. is equivalent to 185° W.; but October 7 in the first case is October 6 in the second. If such noting of the day, which is as much a part of the expression of the local time as are the hours and minutes, is attended to, we have the simple rule, common in navigation and the use of an ephemeris, "To the local time add the longitude if west, subtract it if east, to obtain the corresponding time of the prime meridian;" and this rule includes the day as well as its parts.

Sir John Herschel and others have proposed that longitudes should be reckoned westerly from 0 to 360° . This would complicate

the expression for the local day, and congruity would require that the change of day should be at the prime meridian, which would cause great inconvenience and even confusion.

There are some observations of terrestrial phenomena, which it is desirable to have made simultaneously in the same continent or in all parts of the world. This was notably the case in the magnetic crusade some forty years ago, when certain instants of Göttingen times were specified; but the observers had no difficulty, each for himself, in determining and using his corresponding local time. And in meteorological observations, if times are prescribed in the time of any specific meridian, the observers, if of sufficient intelligence to make valuable observations, can readily convert these times into their local times, or the reverse. The constant difference of longitude, expressed in time, is all that each one requires for the purpose.

The great call for a standard time has been made with regard to railroads. A *uniform* time for each road, or connecting system of roads, is needed for regulating the times of starting and the arrival of trains, which each road can best determine for itself, and the time-tables and clocks at the several stations may be reserved for the employés of such roads only. If the time-tables published for information of the travelling public are given in the local time of each place, or a column of constants for the reduction of the published times to the local times is given, the needs of the traveller seem to be sufficiently provided for. A local time differing but little from local mean-solar time is needed to meet the wants of the social and industrial interests of the country, and if it be exactly the mean-solar time, it varies from place to place directly with the longitude.

An essential is that each time-table for railroads should state distinctly what time is used. A neglect of this has and will produce uncertainty and confusion. In a leading railroad guide I found, at a place which I visited, three time-tables for the same road, without any statement that one of them was in New York time, the others in time of other places.

The suggestion that the dials of clocks should indicate an entire day of twenty-four hours instead of a half day of twelve hours is valuable to a certain extent. This is done in astronomical clocks, and in the astronomical mode of noting time. It would be an improvement in chronometers for nautical use, but sufficient if the

dial be marked into the two periods of twelve hours each, into which common, universal use divides the day.

It would seem to be impracticable to change materially the use of local-mean time, now common throughout the country; nor is such change desirable or needed.

It is only within forty years that mean time has been substituted for apparent time in many of our cities, though its advantages had long been recognized by astronomers and time regulators; and within twenty years that the sun's rising and setting have been stated in mean, instead of apparent, time in the popular almanacs of the day.

The subject-matter was further discussed by Messrs. Doolittle, Elliott, Riley, Hilgard, Gilbert, and Mussey.

Mr. G. BROWN GOODE then read a paper

ON THE FISHERIES OF THE WORLD.

This has been essentially printed in the "Cyclopædia of Political Science, Political Economy," etc., edited by John J. Lawlor, published at Chicago, vol. 2, pp. 211-231, (Art. "Fisheries,") 1883.

222D MEETING.

OCTOBER 21, 1882.

The President in the Chair.

Twenty-two members were present.

The minutes of the last meeting were read and adopted.

Mr. S. C. BUSEY read a paper

ON THE INFLUENCE OF THE CONSTANT USE OF HIGH-HEELED SHOES UPON THE HEALTH AND FORM OF THE FEMALE, AND UPON THE RELATION OF THE PELVIC ORGANS.

(The paper will appear in full in vol. 7, Gynecological Transactions.)

[Abstract.]

The foot and its coverings is not a new subject. Far more attention, however, has been given to the style and display of the covering than to the comfort and physical well-being of the foot. From this point the author gave a historical resumé of the different coverings for the feet which had been used as far back as the an-

cient Egyptians. The heel at first was designed to make short men look tall, and like other parts had undergone many changes to suit the whims of fashion and taste. During the reign of Louis XVI this objectionable style began to disappear, but has been again revived, and is perhaps more general now than at any previous time. Then followed a brief summary of the causes that produced deviations of form, with special reference to the effect of the constant use of French high-heeled shoes. Diagrams were exhibited showing the distortions of the feet caused by them, and the consequent changes in the joint-flexures and spinal curves. He claimed that the primary deflection took place at the base of the line of gravitation, and above this point there were greater or lesser alterations of the flexures and curves along the bony framework. Special attention was directed to the increased obliquity of the pelvis, and to the probable corresponding change in the position of the womb and other pelvic organs, which might be an important factor in the causation of some of the disorders of the female reproductive organs.

The subject-matter was discussed by various members.

A communication was submitted by Mr. THEODORE GILL

ON THE CLASSIFICATION OF THE INSECTIVOROUS MAMMALS.

In 1875 the author published a "Synopsis of Insectivorous Mammals" in the Bulletin of the United States Geological Survey of the Territories, under Hayden, (vol. 1, No. 2; 2d series, 1875, pp. 91-120,) and proposed several modifications in the classification. The principal of those modifications were (1) the union of the typical Insectivora and Dermoptera (*Galeopithecus*) is one order, as had been long before proposed by Frederic Cuvier and Wagner, but their distinction as two suborders; (2) the distribution of the true insectivores under two groups characterized by their molar dentition, and the complete subordination of the form of the body, and (3) the combination of families into super-families, and (4) the subdivision of several into subfamilies. The scheme thus promulgated has met with gratifying and unexpected favor, and has been essentially adopted by Messrs. Coues, Jordan, Dallas, Trouessart, and Dobson. Surgeon-Major Dobson's opinion is especially weighty, as he has undertaken a monograph of the order, and his opportunities for investigation have been unequalled. Since the publication of the Synopsis, in 1875, several forms have been made

or become known which compel the recognition of new subordinate groups in the order; and Major Dobson has also proposed to raise the Solenodontinæ from the rank of a subfamily of Centetidæ to that of a family by the side of the latter. The assessment of the comparative value of different groups is a difficult and delicate task, and much can be said for as well as against any given proposition. The Solenodonts are doubtless as distinct from their nearest of kin as are some of the generally admitted families of mammals, and therefore it will be quite proper to recognize the family value of the type. But there are other groups of Insectivora which have been associated together in the same families which are equally or more entitled to the same distinction. Indeed, the only subfamilies of the "Synopsis of Insectivorous Mammals" which do not contrast more seem to be the Gymnurinæ and Erinaceinæ. If the Solenodontidæ are to be differentiated with family rank from the Centetidæ, so should the others. We would then have the following families:

SUBORDER DERMOPTERA.

1. Galeopithecidæ.

SUBORDER BESTIÆ.

DILAMBODONTA.—Bestiæ with broad molar teeth surmounted by W-shaped ridges.

TUPAIOIDEA.

2. Tupaiidæ.

3. Macroscelididæ = Macroscelidinæ.

4. Rhynchocyonidæ = Rhynchocyoninæ.

ERINACEOIDEA.

5. Erinaceidæ, with the two subfamilies Gymnurinæ and Erinaceinæ.

SORICOIDEA.

6. Talpidæ = Talpinæ.

7. Myogalidæ = Myogalinæ.

8. Soricidæ.

ZALAMBODONTA.—Bestiæ with narrow molar teeth having V-shaped ridges.

CENTETOIDÆ.

- 9. Centetidæ = Centetinaæ.
- 10. Oryzoryctidæ = Oryzoryctinaæ, *Dobson*, Mon. Insect., pp. 2, 71. 1882.
- 11. Solenodontidæ, *Dobson*, Mon. Insect., pp. 3, 87. 1882.
- 12. Potamogalidæ.
- 13. Geogalidæ = Geogalinaæ, *Dobson*, Mon. Insect., p. 2. 1882.

CHRYSOCHLOROIDEA.

- 14. Chrysochloridæ.

The "Monograph of the Insectivora," by Surgeon-Major Dobson, will fill a long-felt want, and exceptionally well represent the present condition of our knowledge respecting the existing representatives of the order.

223D MEETING.

NOVEMBER 4, 1882.

The President in the Chair.

Forty-five members present.

The minutes of the last meeting were read and approved.

A communication was made by Mr. G. K. GILBERT:

ON A GRAPHIC TABLE FOR COMPUTATION.

[Abstract.]

On Nov. 17th, 1881, a new method of barometric hypsometry was presented to the Society, and this has since been published in the Second Annual Report of the Geological Survey. It involves a new formula. In the application of that formula an approximate value of the required altitude is first obtained, to which a correction is then added. For the determination of this correction a table was prepared, to be entered with two arguments. Although this table was spread out on six octavo pages, and although the deduced correction is small, it was nevertheless found impracticable to avoid a double interpolation. To escape this inconvenience the graphic table was afterwards devised.

The graphic table consists of three super-imposed sets of lines. In each of two sets the lines are straight, parallel, and equidistant, and those of one set intersect those of the other at right angles.

These represent values of the two arguments. The lines of the third set are curved, and each one represents a value of the correction. In use, the straight lines representing the values of the two arguments are traced to their intersection, and from the relation of this point of intersection to the curved lines the correction is deduced.

This method is theoretically applicable to the tabulation of any quantity which is the function of two variables, but is practically useful only when the quantity to be determined is either expressible by a small number of digits, or else is subject to only a small range of variation.

A second graphic table was exhibited, having for its object the computation of altitude from horizontal distances and vertical angles as data. On this, successive values of computed altitude are indicated by parallel, equidistant, straight lines. Vertical angles are indicated by the directions of lines radiating from a point, but the intervals of these lines are not equal. Distances are measurable along these radial lines, but are not indicated in the drawing. The scale of distances is identical with that of the map, including the points whose altitudes are to be computed. The lines are drawn on tracing-linen.

For the use of this table it is postulated that the points whose altitudes are to be computed are correctly placed upon a map, and that the same map indicates a point from which the elevation or depression angles of the various points were measured. The transparent linen bearing the table is placed over the map and connected with it by a pin passing through the common origin of the radial lines, and also through the indicated position of the station from which the angles were measured. About this point as a centre the table is then moved until the radial line, indicating the vertical angle of one of the points, is brought immediately over the representation of that point upon the map. The position of that point among the parallel lines then indicates the desired altitude.

The use of this device is limited to a special case, but that case is one of frequent recurrence in the preparation of contour maps, and it is hoped that the device will lead to an economy of time.

The principle involved in the application of a *transparent* graphic table permits of the extension of the graphic table to cases involving three arguments. Two sets of lines could be drawn on a lower sheet, and two other sets on an upper transparent sheet, and these

sets could be so constructed that one of them would represent a function of three variables represented by the other three.

The paper was discussed by Mr. HARKNESS and Mr. H. A. HAZEN, Mr. HARKNESS pointed out that the construction of a two-argument computation table by means of curved lines was not novel.

224TH MEETING.

NOVEMBER 18, 1882.

The President in the Chair.

Forty members present.

The minutes of the last meeting were read and adopted.

Mr. E. B. ELLIOTT spoke

ON SURVIVORSHIPS, WITH TABLES AND FORMULAS OF CONSTRUCTION.

(No abstract has been furnished.)

Mr. H. A. HAZEN submitted a paper

ON THE COMING WINTER OF 1882-'83.

The following is an abstract :

It has been a great desideratum, and one which has called out the efforts of many men, to determine in advance the probable character of a season. A prominent meteorologist has inferred that the coming winter is to be a very severe one, because, as he says, "every one knows that a cold and wet summer is invariably followed by a cold and stormy winter." In order to obtain probable sequences in the weather, if we could in any way determine the mean temperature or pressure over an extensive region, it would seem as though results would be far more satisfactory than those from a single station. The following plan has been adopted for ascertaining such mean results:

We may draw isobars or any isometeorologic lines upon a map of a country; then we may rule a large number of squares upon glass or some transparent substance; and after that, by placing these squares upon the map, we may at a glance interpolate the exact pressure or temperature in each square, and a mean of all the squares would give a mean for the whole country.

Such results have been determined for the United States east of the 97th meridian for each month since July, 1873. (These were exhibited graphically before the Society.) We find a singular result on comparing these figures with similar figures for the single station of Providence, R. I., (observations at this station, from 1832 to 1876, were kindly furnished the author by the Smithsonian Institution,) namely, a striking uniformity in the values; and we may conclude that, as far as mean monthly temperatures are concerned, we may consider those at any one station fairly comparable with the same over an extensive region.

In the accompanying table each summer, and the following winter, at Providence, R. I., have been considered as cold, cool, mean, warm, or hot; and an effort has been made to establish the character of the winter that follows a summer having any one of the above characteristics:

Year.	Summer.	Winter following.	Year.	Summer.	Winter following.
1832	cold	warm	1857	cold	hot
1833	cool	warm	1858	cold	hot
1834	warm	cold	1859	mean	hot
1835	mean	cold	1860	cool	hot
1836	cold	cold	1861	cool	warm
1837	cold	mean	1862	cold	warm
1838	hot	cold	1863	cold	hot
1839	mean	cool	1864	cold	warm
1840	warm	mean	1865	mean	hot
1841	mean	hot	1866	warm	warm
1842	mean	mean	1867	mean	mean
1843	mean	mean	1868	mean	cold
1844	mean	warm	1869	cool	warm
1845	cool	cool	1870	hot	hot
1846	cold	hot	1871	mean	cold
1847	mean	hot	1872	hot	cold
1848	warm	cool	1873	mean	mean
1849	mean	hot	1874	mean	cold
1850	mean	hot	1875	cold	mean
1851	mean	cool	1876	warm	cold
1852	warm	warm	1877	warm	hot
1853	warm	cool	1878	warm	cool
1854	warm	cool	1879	mean	hot
1855	hot	cold	1880	hot	cold
1856	hot	cold	1881	warm	hot

On examining this table we find that of the eight cold summers three were followed by a hot winter, three by a warm winter, one by a mean winter, and one by a cold winter, which gives one out of eight cold summers followed by a cold winter, and six by a hot or warm winter. Taking all the cases, in forty-eight per cent. of them any summer was followed by a winter of an opposite character; in forty-two per cent. the summers or winters were mean, and in only ten per cent. of the cases were the summers followed by winters of the same character.

Making a similar comparison at Fort Snelling, Minnesota, we find, out of the sixty-eight summers and winters on record at that station, that fifty-two, or seventy-six per cent., were followed by a season of the opposite character; ten, or fifteen per cent., by a season of the same character; and six, or nine per cent., were doubtful.

We may also infer the character of the coming season for the United States by noting the movement of the permanent winter area of high pressure in respect to the Rocky mountains. It would seem as though these tended to ward off the cold if the high area settles down to the west of the range.

The winter of 1877-'78 was warm, for during every month of that season the high pressure was west of the Rockies, and the cold waves were effectually barred from the Eastern States. In December of 1877 the high pressure was spread over a vast extent of territory west of the range, and the temperature in the east rose to 7.2 degrees above the average.

The winter months of 1880-'81 were cold. During that time the high pressure was well to the east of the Rockies, and the temperature in the east fell below the average from two to six degrees. The winter of 1881-'82 was warm, as the following tabulated form shows, the plus sign indicating so many degrees above the average.

Month.	Temperature.	Position of high pressure.
1881, September.....	+4°.6	Normal.
October	+3°.8	Normal.
November.....	+2°.2	Strong west of range.
December.....	+7°.7	Strong west of range.
1882, January	+2°.7	Strong west of range.
February.....	+5°.6	Strong west of range.

It is now too early to determine exactly what the weather of

the winter of 1882-'83 will be, but the indications are that it will be a medium rather than a severe one, as some have predicted. The past summer having been cold and stormy, a warm winter ought to follow; and the high pressure during last September was slightly west of the Rockies, while during October it was so far to the West and North as to rest over the Cascade range in Oregon. If it continues west of the Rocky-Mountain range a severe winter is not probable.

Mr. HENRY FARQUHAR commenced a communication on

EXPERIMENTS IN BINARY ARITHMETIC.

The meeting was adjourned at the usual hour, (10 o'clock,) with the understanding that the unfinished communication should be taken up at a subsequent meeting.

225TH MEETING.

DECEMBER 2, 1882.

The President in the Chair.

Fifty members present.

The minutes of the last meeting were read and adopted.

In accordance with the by-laws of the Society, the President, Mr. WILLIAM B. TAYLOR, delivered the annual address.

ANNUAL ADDRESS

ON PHYSICS AND OCCULT QUALITIES,

BY WILLIAM B. TAYLOR.

"Vis abdita quædam."

LUCRETIUS. (*De R. N.*, lib. v. 1232.)

1. *The Dynamic and Kinematic Theories of Force.*

From the remarkable success of scientific investigation in assailing the domain of darkness,—in continually bringing the phenomena of nature more and more under the recognized empire of certain necessary laws and principles, the induction seems natural that outstanding mysteries—the ultimate constitution of matter, the nature and genesis of life and of mind itself—must in time yield to the same persistent siege of searching analysis, and be reduced to subjection under the same government, as simple servitors of an all-embracing mechanical philosophy.

In recent years, a still further induction has been ventured upon by some, to wit, that even the fundamental laws themselves of all physical action must, when properly formulated, be interpreted by simple mechanics;—all properties of matter resolved into mass or inertia, and finite extension or form,—all potentiality of matter into varying modes of motion. And it has been strongly maintained by this class of physicists, that until such consummation, the mind must still be held in thrall of mysterious unimaginable powers, the helpless devotee of "occult qualities" which science in the past has so laboriously and successfully endeavored to relegate to the shadowy liminary of metaphysics. This form of speculative doctrine, (premonitions of which may be traced back several hundred years,) may now be regarded as having attained the importance and cohesion of a school, numbering in its following a few quite eminent disciples, who agree in denying the real existence of any inherent "forces" in matter, and in holding such a designation to be merely a convenient but provisional ideal abstraction. While on the other hand the large majority of scientific thinkers (perhaps comprising most of those who have reached the conservatism of middle age) still adhere to the older conception of primeval "force" as an essential hypostasis of the operations of nature. And thus the battle so

long waged (and so long practically decided) between realism and nominalism in the field of mind, bids fair to be revived (though under quite other auspices) in the field of matter. These two modes of thought may be conveniently designated the *dynamic* and the *kinematic* theories of physics. In the terminology of the *Philosophie Positive*, the dynamic theory still lingers in the shaded vale of "metaphysics," while the kinematic theory has reached the sunny hill of "positivism."* An attempt to examine and compare these divergent lines of interpretation may be a not unprofitable exercise.

The Cohesion of Matter.—Among the earliest of our experiences is the perception that the bodies around us possess in varying degrees a quality of "hardness;" and the child who gathers a rounded pebble on the beach, (if perchance inspired by its inquisitive instinct to see what the interior looks like,) discovers that to break the pebble requires the heavy and repeated strokes of a stone much larger than itself. Whence this remarkable tenacity of coherence? Whence the striking physical difference between the pebble and an equivalent mass of very fine sand?

From a large variety of facts observed in the actions of solution, of fusion, of evaporation, of the very existence of a kinetic temperature in bodies, in the phenomena of crystallization, of isomorphism, of definite and unvarying numerical mass-ratios in chemical combinations, of polymerism or serial groupings in multiple proportion, of isomerism, of allotropy, and of other more recondite habitudes of matter, the general conviction has been reached (by what has been called "a consilience of inductions") that all substance is a collection of constituent molecules of probably uniform magnitudes held together by some powerful agency. A few it is true have asserted their superiority to such popular weakness as the admission of the atomic theory; but as their vague suggestion of some continuous or colloidal form of substance has not even pretended to interpret any of the classes of phenomena just alluded to, such dis-

* AUGUSTE COMTE, in his *Positive Philosophy*, maintains that "Forces are only motions produced or tending to be produced. - - - We hear too much still of the old metaphysical language about *forces* and the like; and it would be wise to suit our terms to our positive philosophy." (Harriet Martineau's Translation. London, 1853: book I, chap. 4.) Even *inertia* is treated as a metaphysical fiction.

sent may be summarily dismissed as the mere exhibition of an unprofitable mental captiousness.*

The kinematist repudiating any attractive force in nature would explain the strong cohesion of matter by the hypothetical external pressure of a hypothetical surrounding fluid. The Plumian professor of astronomy and physics in the University of Cambridge—James Challis—(a successor of Roger Cotes and of George B. Airy) has declared “the fundamental and only admissible idea of *force* is that of pressure, exerted either actively by the æther against the surfaces of the atoms, or as re-action of the atoms on the æther by resistance to that pressure.”† And the professor of physics in the University of Edinburgh—Peter G. Tait—having also relegated the source of all material energy to the action of the highly attenuated matter diffused through space, thinks it probable that “*force*” has no existence, excepting as a convenient expression of a mere rate of transference of kinetic energy.‡

* “The existence of atoms is itself an hypothesis, and *not* a probable one. - - - All dogmatic assertion upon such points is to be regarded with distrust.” (*A Manual of Inorganic Chemistry*, By CHARLES W. ELIOT and FRANK H. STORER. 2d edition, revised, New York, 1868: chap. XXV, p. 605.) And yet these negative dogmatists have not shown themselves capable even of *thinking* of so elementary a fact in their science as “polymerism” apart from the terms of the atomic conception. As Prof. J. CLERK MAXWELL has well observed, “The theory that bodies apparently homogeneous and continuous are so in reality, is in its extreme form a theory incapable of development. To explain the properties of any substance by this theory is impossible.” (*Encyclopædia Britannica*. 9th ed., 1875: art. “Atom,” vol. III, p. 38.) The objection to atomism sometimes urged—that since magnitude is admitted abstractly or mathematically to be infinitely divisible, therefore any finite particle of matter must also be *physically* so conceived,—betrays so strange a confusion of ideas as to merit no serious answer. Yet so illustrious a mathematician and philosopher as LEONARD EULER was guilty of this gross paralogism. (*Letters to a German Princess*. May 3, 1761: vol. II, let. 9.)

† *Principles of Mathematics and Physics*. By JAMES CHALLIS. 8vo. Cambridge, 1869: hyp. v, p. 358.

‡ In an evening lecture on “Force” delivered September 8, 1876, at Glasgow, (during the session of the British Association,) Prof. TAIT announced that “there is probably no such *thing* as force at all! That it is in fact merely a convenient expression for a certain *rate*.” And referring to the corpuscular hypothesis of force, he thought “The most singular thing about it is that if it be true, it will probably lead us to regard all

It is very certain, however, that the hypothetical fluid of cohesion-pressure must be something entirely different in constitution from the luminiferous æther, since any mode of action which could be imagined for compressing together the elements of matter, would necessarily be incompatible with the transmission of solar radiation having the quality and properties of the vibrations actually observed. The fantastic scheme of Le Sage (in which cohesion is effected by the quaquaversal impacts of infinitesimal corpuscles flying swiftly in all directions, and whose various sizes determine the differing collocations of chemical unions,)—notwithstanding the approval of Prof. Tait,*—scarcely requires a “serious consideration.”† Nor has any form of impact, of pressure, or of undulation, yet been proffered by the ingenuity of the kinematist—either at all adequate to the maintenance of the known conditions of matter, or indeed in itself at all conformable with any known modes of action.

The dynamist having searched in vain for any plausible co-ordination of the indisputable facts of cohesion with an intelligible mechanical agency, simply acquiesces in the result, and without invoking the unknown or the irrelevant, accepts this established property as ultimate and inexplicable.

kinds of energy as ultimately kinetic.” (*Nature*. Sept. 21, 1876: vol. XIV, pp. 459, 463.)

The climax of kinematism however has been reached by the inventor and apostle of the “fourth state of matter,”—WILLIAM CROOKES, who is disposed to dismiss matter itself to the same limbo—of changing position: “From this point of view then matter is but *a mode of motion*; at the absolute zero of temperature the inter-molecular movement would stop, and although *something* [?] retaining the properties of inertia and weight would remain, *matter*—as we know it—would cease to exist.” (*Nature*. June 17, 1880: vol. XXII, p. 153.) This seems to touch the sublime “secret” of GEORGE WILLIAM FREDERICK HEGEL, in which “nought is everything, and everything is nought.”—*Seyn und Nichts ist dasselbe*.

* *Lectures on some recent advances in Physical Science*. By P. G. TAIT. 12mo. London, 1876: lect. XII, p. 299.

† “The hypothesis of Le Sage - - - is too grotesque to need serious consideration; and besides will render no account of the phenomenon of elasticity.” Sir JOHN F. W. HERSCHEL, “On the Origin of Force.” (*Fortnightly Review*. July 1, 1865: vol. I, p. 438. Also, *Familiar Lectures on Scientific Subjects*. 12mo. London, 1866: art. XII. pp. 466, 467.)

The Elasticity of Matter.—To select another illustration, the child throwing his rounded marble downward on a stone pavement finds to his surprise that it rebounds like his play-ball, and that he may, without stooping, catch it in his hand. What explanation is to be given of this direct and sudden reversal of movement? To this familiar quality of matter, we give the name of "elasticity." But by what more simple formula of mechanics shall we represent to ourselves this property *elasticity*? Kinematists abjuring alike objective "qualities" and subjective "abstractions" have been severely taxed in their attempts either to ignore the attribute or to reduce the phenomenon to some phase of molecular vibration.

Some few—consistent in their rejection of all quality from material substance—have boldly denied the existence of elasticity; or rather have ventured to affirm that perfectly hard or inelastic atoms or masses would on collision alike rebound, precisely as though they were elastic.* This startling conclusion—apparently necessitated by their fundamental assumption "the conservation of motion"—requires for the intelligent student of rational mechanics, no discussion.

Other kinematists have resolutely endeavored to explain the resilience of colliding bodies as the special resultant of composite motions. One of the most earnest of these has been the Italian astronomer and physicist Angelo Secchi, who in an elaborate essay on the ultimate identity of all the physical forces as simple modes of motion, remarks: "It is evident that this 'elastic force' can be admitted only as a secondary force derived from another antecedent in an aggregate of atoms, that is in a compound molecule; and that it cannot be admitted as pertaining to the elementary atoms. Indeed, elasticity in its ordinary acceptation requires a void space within the molecule to allow the form to be changed by compression and afterward restored; while on the contrary it is the necessary condition of real atoms—by conception—to be impenetrable [in-

* This thesis was maintained by JOHN HERAPATH, in his work on *Mathematical Physics*. 8vo. 2 vols. London, 1847: (vol. I, pp. 106-137.) As stated by NEWTON however, "Bodies which are either absolutely hard, or so soft as to be void of elasticity will not rebound from one another. Impenetrability makes them only stop. If two equal bodies meet directly *in vacuo*, they will by the laws of motion stop where they meet, and lose all their motion and remain in rest, unless they be elastic and receive new motion from their spring." (*Optics*. 2d edition, 1717: book III, Qu. 31.)

compressible] and not an aggregation of other solid particles. Hence they cannot be supposed to have any internal voids in which their parts could be contracted or dilated. - - - We believe we are able to show that it is by no means a necessary position to accept this elastic property as a primitive force, but that the apparent repulsion of these atoms and their rebound originates solely from their proper motion, and for this it is sufficient simply to suppose them to be *in rotation*.”* He then proceeds to develop his theory of mechanical elasticity from the co-operation of the projectile motion of bodies with the internal rotations of their constituent molecules; citing in support of his assumption, the mathematical researches of Poinso†. In this important foundation of his system however, the zealous physicist has built upon an entirely mistaken apprehension of true mechanical principles, and hence of course upon a strange misapprehension of the actual discussion by Poinso. This eminent mathematician who has investigated so thoroughly the theory of rotatory movements has shown that in the collision of inelastic bodies, endowed with rotation, the velocity of deflection may in special cases exceed the velocity of incidence, in other special cases may be just equal to it, and lastly in general will fall short of it, being in many cases entirely destroyed. Thus a rotating inelastic body has two points between the center of inertia and that of percussion, which on impact with a fixed resistance in the line of their direction will produce a resilience of higher velocity than that of collision,—of course by the conversion and absorption of so much of the rotary motion. There are other two points from the direction of whose impact will result a velocity just equal to that of the original motion of the body;—in the one case absorbing one-third of the rotary motion, in the other case absorbing two-thirds of it. If the impact be in the line of the center of inertia, the whole of the translatory motion is arrested without affecting the rotary motion. [In the case of two equal inelastic spheres rotating with equal and opposite velocities on parallel transverse axes and meeting at a point on their equators, the bodies

* *L'Unità delle Forze Fisiche*; Saggio de filosofia naturale. Del P. ANGELO SECCHI. 12mo. Rome, 1864: chap. I, sect. 6, pp. 36, 37.

† Father SECCHI's reference in a foot-note is to “*Questions dynamiques sur la percussion des corps*: pag. 21 e 29, dell' edizione a parte, ed anche il Giornale di Liouville, - - - a pag. 36.”

would lose entirely their travelling motion, still retaining their rotations. So also if their axes were equally inclined so as to bring the points of impact on corresponding circles of latitude; the limiting case of which would be an impact on their poles of motion in the line of their common axes of rotation.] Lastly if a rotating inelastic body should meet a fixed resistance in the line of the center of percussion, not only the translatory—but the rotary velocity as well—would be entirely destroyed.* If we conceive a molecule as consisting of a congeries of atoms having an orbital revolution (analogous to a solar system), a very similar analysis will apply to the cases of collision.

It is very clear then that the device of storing up additional kinetic energy in the form of internal rotation (or revolution) fails utterly to reproduce the phenomena of motion exhibited by elasticity. The resulting effects cannot be admitted as at all analogous; since the internal kinetic energy assumed is either wholly or largely absorbed and exhausted by a single collision, and a second impact can never reproduce the effects of a first one; while *elastic* force remains perpetual and unimpaired by constant action.

Elasticity accordingly, equally with cohesion, is a fact of nature, a property of matter, which can neither be interpreted by any form of motion, nor resolved into any mechanical concept.† Those therefore who would formulate the elements of things devoid of

* LOUIS POINSON. The latter portion of a series of mathematical discussions under the general title—*Questions dynamiques sur la Percussion des Corps*; published in Liouville's *Journal de Mathematiques* for 1857: vol. II, pp. 281–308.

† “Elasticity without an action *e distant*—even between the adjoining particles—is inconceivable. What is meant by elasticity? Surely such a constitution of the assemblage of particles as makes them recede from each other.” Prof. JOHN ROBISON. (*A System of Mechanical Philosophy*. 8vo. 4 vols. Edinburgh, 1882: vol. III, p. 139.)

“An alteration of the form of a solid body is called a *strain*. In solid bodies strain is accompanied with an internal force or *stress*; those bodies in which the stress depends simply on the strain are called ‘elastic,’ and the property of exerting stress when strained is called elasticity. - - - The general fact that strains or changes of configuration are accompanied by stresses or internal forces, and that thereby energy is stored up in the system so strained, remains an ultimate fact which has not yet been explained as the result of any more fundamental principle.” Prof. J. CLERK MAXWELL. (*Matter and Motion*. 1876: chap. v, arts. 83, 84; pp. 70, 71.

quality, have on their own declaration no right to the use of either term in considering any physical problem.

Were the examination to stop here, it might appear that the only difference between the dynamist and the kinematist is that the former—failing to find any satisfactory explanation of certain habits of matter, despairs of deeper insight and accordingly seeking no further, accepts the conclusion that these are insoluble; while the kinematist more hopeful, has an abiding faith that the same processes which have so successfully (or at least so largely) deciphered the riddles of light, of heat, of gaseous constitution, may be expected in time to resolve these other enigmas though they be not yet expounded. It is necessary therefore to go back still further and examine the character of this induction, by a cursory review of the postulates of the mechanical theory of light, of heat, and of the kinetics of discrete molecules.

2. *The Theory of Molecular Kinetics.*

In the last century both light and heat were generally regarded as material emanations; the former, of radiant corpuscles, the latter, of a peculiarly rare and penetrating fluid. Earlier kinetic hypotheses of these so-called “imponderables”—however ingenious—were not supported by a sufficient induction from observed facts to justly entitle them to unqualified acceptance. And the doubts and difficulties suggested by the speculations of Newton were a striking illustration of his recognized sagacity; notwithstanding the occasional censures of modern popular lecturers, trumpeting their own superior wisdom.

The Vibratory Theory of Heat.—The fluid or “caloric” theory of heat (though often questioned or opposed) was first decisively overthrown at the close of the century by Benjamin Thompson, an expatriated American, better known as Count Rumford, whose experiments unescapably demonstrated the resolution of heat into an intestine motion, by the fact of its interminable generation in friction through the agency of continued motion.* It was not how-

* *Phil. Trans. Roy. Soc.* 1798: vol. LXXXIII, pp. 80-102. This admirable memoir read before the Royal Society of London, January 25, 1798, (in which RUMFORD—from the fact “that the source of heat generated

ever until about the middle of the present century that the conception attained a scientific definiteness and currency through the accurate determination of the kinetic or dynamic value of heat.

The Undulatory Theory of Light.—Nearly simultaneously with the work of Rumford in the field of heat, the investigations of Dr. Thomas Young, at the beginning of this century, relative especially to the interference of two luminous rays in particular cases, in like manner overthrew the theory of corpuscular emission in the field of light, by demonstrating a destruction or obliteration—quite intelligible as a conflict of wave motion, but entirely inadmissible and unthinkable as a mutual extermination of conflicting substance.* Through the refined labors of Young,—admirably assisted and re-enforced by the able efforts of his skillful and worthy rival Fresnel,—the varied and complex phenomena of dioptrics were more and more fully brought under the dominion of a rational kinetics. And thus it resulted that the new doctrine of insensible motion obtained from the scientific world a much more rapid and general acceptance in its application to light than in its application to heat. So that it was not unusual some forty or fifty

by friction in these experiments appeared evidently to be inexhaustible," argued that this product "cannot possibly be a material substance:") may be said to furnish the first rough approximation to the mechanical equivalent of heat. The author estimated the heat produced by a one-horse power as equivalent to that obtained from the burning of nine wax candles, each three-quarters of an inch in diameter; or to the combustion of a little more than one-third of a pound of wax in two and a half hours. This essay also presents the first suggestion of the mechanical correlation of animal power with heat motion.

Dr. YOUNG held that Rumford's experiments "appear to afford an unanswerable confutation of the whole of this doctrine:—[that of a 'caloric' fluid.] - - - If heat is not a substance, it must be a quality; and this quality can only be motion." (*Lectures on Natural Philosophy*. 1807: lect. 52: vol. I, pp. 653, 654.)

"The hypothesis of caloric" says Prof. J. CLERK MAXWELL "or the theory that heat is a kind of matter is rendered untenable—first by the proof given by Rumford that heat can be *generated* at the expense of mechanical work; and secondly by the measurements of Hirn, which show that when heat does work in an engine, a portion of the heat *disappears*." (*Theory of Heat*. 1872: chap. VIII, p. 147.)

* "*Phil. Trans. Roy. Soc.* A memoir read July 1, 1802: vol. XCII. p. 387; and one read November 24, 1803: vol. XCIV. pp. 1-16.

years ago, to find our college professors zealously inculcating the undulatory theory of light, while still maintaining the hypothesis of a "caloric" for heat.

William Herschel had found, at the beginning of the century, that the solar spectrum, as produced by an ordinary glass prism, manifested a heating power slight at the violet end, but gradually increasing to the red end, and extending a considerable distance beyond the less refrangible limit of visible rays, near which limit the maximum effect was reached.*

Johann Wilhelm Ritter, of Jena, a year later found that the chemical action of the solar spectrum, as exhibited in the darkening of silver chloride, increased toward the violet extremity, attaining a maximum beyond the most refrangible limit of luminous dispersion.† Hence, it came to be generally believed that the solar rays comprise three essentially distinct and independent kinds of energy, representing three different forms of wave-motion. This appeared the more probable from the entirely dissimilar orders of effect observed (as interpreted by the impressions of our senses), in caloric energy, in optical luminosity, and in chemical agency.

It was shown however by Alexandre Edmond Becquerel that the so-called chemical rays were not distinguishable by their refrangibility, and that photographic effects could be obtained with suitable re-agents from any region of the spectrum.‡ And finally, by the researches of Dr. John W. Draper, it was fully established that Herschel's results depended on the great distortion (as well as unequal absorption) inseparable from every prismatic or refractive spectrum, and that Ritter's results depended on a very limited and insufficient induction. And thus it has slowly come to be recognized that in every normal spectrum, freed from distortion or selective absorption, (and equally freed from selective generalization), the three classes of effects, thermal, photic, and actinic, are equably or proportionally distributed; that as these several activities are equally amenable to polarization, to interference, and to spectral irradiation and absorption, there is in fact but a single form of

**Phil. Trans. Roy. Soc.* 1800: vol. xc, pp. 291, 318, 439, 440.

†Gilbert's *Annalen der Physik*. 1801: vol. vii, p. 527. Nicholson's *Journal of Natural Philosophy*, [etc.] August, 1803: vol. v, p. 255.

‡*Annales de Chimie et de Physique*. April, 1849: vol. xxv, pp. 447-474.

ætherial undulation, the differences of whose manifestations depend entirely upon the nature of the body, organic or inorganic, on which it falls.*

Molecular Thermo-dynamics.—Passing from the wave theory of radiation to the related subject of the internal re-actions of bodies, the application of thermo-kinetics to the facts of temperature has taught us that the molecules of all bodies are in a state of very rapid though minute movement, and that this movement, while being constantly transferred and expended, (and thus ever tending to the absolute zero,) is yet incessantly maintained in varying quantity by repeated re-enforcements from natural and artificial sources of heat, and by mutual interchanges. In the case of solid bodies, whose constituent molecules are held together by what we must call (in default of any names as yet invented by the kinematist) the qualities of *cohesion* and *adhesion*,—their mutual contact being resisted and prevented by what we must for the present call a repellant quality, the temperature motion is in the nature of an oscillation or rather irregular reverberation within the narrow limits of opposite resistances, by which the relative mean position of the particles and the stability of the body are preserved. By the term “cohesion” is designated simply the observed fact of a resistance to divellent or tensile stress; by the term “adhesion” is designated the observed fact of resistance to torsional or shearing stress.

When the energy of the molecular movements is increased until the modulus of “adhesion” is equalled, the point of melting is reached, and the molecules instead of being restored to their antecedent positions are carried irregularly from the influence of neighbor to neighbor, and thus become fluent by being deflected among each other in all possible directions. In this “liquid” condition of

**Am. Jour. Sci.* Jan. and Feb., 1873: vol. v, pp. 25-38, and 91-98. Dr. DRAPER'S results (so far as the refrangibility of radiant heat is concerned) have recently been confirmed by the refined investigations of Prof. S. P. LANGLEY, by means of his “actinic balance.” (*Proceed. Am. Acad.* Jan., 1881: vol. XVI, p. 342; *Am. Jour. Sci.* March, 1881: vol. XXI, p. 187; *Nature.* Oct. 12, 1882: vol. XXVI, p. 588.)

“A ray of specified wave-length and specified plane of polarization, cannot be a combination of several different things, such as a light-ray, a heat-ray, and an actinic ray. It must be one and the same thing, which has luminous, thermal, and actinic effects.” J. CLERK MAXWELL. (*Theory of Heat.* 1872: chap. XVI, p. 218.)

the mass, adjacent molecules although entirely freed from the adhesion which constitutes rigidity, yet (as has been shown by Joseph Henry) preserve their mutual cohesion practically unimpaired : * and hence devious as may be their wanderings, no portion of their excursions can be called a free path.

If the rapidity of the mean internal motion be still further accelerated until the momentum of the molecules is equal to their modulus of "cohesion," the temperature of evaporation is reached, and the molecules are impelled from their restraining bonds into a free flight, which so long as undisturbed, continues (by the first law of motion) in an indefinite straight path in the direction of impulse. The strength of these two bonds—*adhesion* and *cohesion*—differing very widely in different substances, is thus measured by the amount of kinetic energy absorbed in overcoming them,—the so-called "latent heat" of fusion and of evaporation. In the case of ice, the strength of the molecular adhesion is considerably less than the sixth part of that of the cohesion.

We thus perceive how the most solid bodies—even at low temperatures—are exposed to surface evaporation without the opportunity of passing through the liquid state ; since external molecules from the great irregularity of their short oscillations, must occasionally by the composition of motions from concurrent or immediately successive shocks, acquire a velocity transcending the bonds of cohesion, and thus escape entirely from the mass.

We accordingly learn by the kinetic theory of gases that the discrete or isolated molecules are flying about in all directions in straight lines until by encounters with other molecules (or with material barriers) their course is deflected. During the brief period of encounter (the disturbance of mutual encroachment), the trajectory becomes a minute hyperbola. From the infinite variety of possible impacts we also learn that each molecule must necessarily be constantly changing within very wide limits the direction, the velocity, and the length of its free excursions ;—even when a perfect equilibrium of temperature imports that the mean kinetic energy of the entire system is constant and uniform.

It is important for us to bear in mind that this wondrous theater of continual intestine commotion does not present an example of a

**Proceed. Am. Phil. Soc.* April 5, & May 17, 1844 : vol. iv, pp. 56, 57 ; and 84, 85.

mechanical "perpetual motion:" the average velocity of any appreciable volume of gaseous molecules subsists only so long as no work is effected. By whatever amount any considerable number of flying particles impart motion to slower groups, or to a solid mass, by this amount do they reduce their own speed, and thus represent a diminished temperature. By whatever amount they receive any average increase of velocity from repeated impacts or from compression within a contracted inclosure, by this amount do they represent an elevation of temperature, at the expense of the bodies from which such additional energy is derived.

The Kinetic interpretation of the Laws of Gases.—It has been shown by Clausius that the number of collisions of a molecule in a given time is proportional to the mean velocity of all the molecules, to their number in a given volume, and to the square of the distance between the centers of two molecules when at nearest approach,* or at what has been called their dynamic contact. By the mathematical investigations of Krönig, Clausius, Loschmidt, and Maxwell, the foundations of a molecular physics have been successfully established; and the laws of gaseous action thus far experimentally ascertained, have been found to result deductively as the necessary consequences of the kinetic theory.

Thus the kinetic energy of any volume of molecules (which represents the temperature of the gas) being the product of molecular weight or mass by the mean square of the velocity, it follows that the relative rates of *effusion* and *diffusion* must both be inversely as the square roots of the masses,—that is of the gaseous densities;—the law of Graham.

It also follows that in the case of diffusion, by reason of the proportional retardations due to more numerous collisions from the presence of other gas, the coefficient must be lower than in the case of effusion.

In any mixture of gases, since from the mutual encounters of molecules of different mass, the average kinetic energy will be the same for all masses, or the mean squares of the velocities will be inversely as the respective masses, it follows that in different in-

*"It is to Clausius that we owe the first definite conception of the free path of a molecule and of the mean distance travelled by a molecule between successive encounters." JAMES CLERK MAXWELL. (*Encyclopæd. Brit.* 1875: vol. III, p. 41.)

closures at the same temperature (*i. e.*, the same energy)—for equal pressures there must be the same number of impacts on any given area, or in other words that the same volume must contain the same number of molecules whether light or heavy :—the law of Avogadro and of Ampère.

And conversely, under the same conditions of pressure (or surface impacts) and of temperature (or kinetic energy), the number of molecules being the same, and the masses of the molecules being the only variable,—the densities of different gases must be proportional to their molecular weights or the masses of their individual molecules :—the law of Gay-Lussac.

Since the sum of the moving forces or the expanding power of the molecular excursions is directly proportional to their kinetic energy, it follows that the volume of a true gas under uniform pressure must be proportional to this energy, that is to the absolute temperature :—the law of Charles and of Dalton.

Since the same kinetic energy of the molecules must exert the same impulse, or the temperatures being constant, they must have a definite mean momentum, and each molecule must execute on an average the same number of impacts with the same energy, it follows that the pressure is directly proportional to the number of molecules ; or in other words that the volume of a true gas at any given temperature is inversely proportional to the pressure :—the law of Boyle and Mariotte. Or combining the last two laws, the volume of a gas multiplied by its pressure is directly proportional to the square of the mean molecular velocity, or the absolute temperature. The slight departure from the law of Boyle and Mariotte observed in most gases when compressed (the internal pressure being somewhat in defect,) indicates a small range of attraction between the molecules when brought close together.*

In addition to the external kinetic energy of the molecule due to its velocity of translation, it possesses an internal kinetic energy due to oscillation or rotation of its parts (its constituent atoms) ; and this internal energy according to Clausius—tends to a constant ratio with the external energy. The amount of energy received or

* " In the case of carbonic acid and other gases which are easily liquified, this deviation is very great. In all cases, however, except that of hydrogen the pressure is less than that given by Boyle's law, showing that the *virial* is on the whole due to *attractive* forces between the molecules." JAMES CLERK MAXWELL. (*Encyclopæd. Brit.* 1875 : vol. III, p. 39.)

expended by a gas in gaining or losing one degree of temperature (which is known as its "specific heat") is proportional to this constant ratio; and hence the specific heat of a gas is inversely proportional to the molecular mass;—that is to say, to the specific gravity of the gas:—the law of Dulong and Petit.

As the entire kinetic energy—molecular and atomic, is necessarily tending constantly to a dynamic equilibrium both with regard to any connected volume constituting a system, and with regard to any kinetic energy of the circumambient æther as well, there is a continual and mutual transfer of such energy:—the theory of exchanges announced by Prevost.

Mean Length of Molecular Excursions.—By a neat application of the calculus of probabilities, Clausius has determined that of the whole number of free molecular excursions in a given time, (in any large inclosure,) those having less than the mean length will be 0.6321; or nearly double the number of those having the mean length or exceeding it. He supposes that under ordinary conditions, the mean length of a free excursion of our air molecules is about sixty times the mean distance between them.

Maxwell has pointed out that three phenomena dependent on the length of the free excursions of gaseous molecules, furnish functions from which the mean length of such paths may be estimated; first, the rate of gaseous diffusion (or the bodily transfer of matter); second, the rate of diffusion of their momentum, or the degree of gaseous "viscosity" (dependent on the transfer and equalization of motion); and third, the diffusion of their kinetic energy or temperature, (the conduction of heat). In our atmosphere, under ordinary conditions (30 inches and 60° F.) the mean length of the molecular path is thus estimated at about the $1 \div 300,000$ of an inch, or about one-sixth of a wave-length of yellow light.

The average molecular velocity of oxygen has been estimated at 1640 feet per second;* and of nitrogen (which constitutes about three-fourths of our atmosphere) at 1754 feet per second; while hydrogen molecules having but one-sixteenth the weight or mass of those of oxygen, would have under the same conditions, four times their average velocity, or 6560 feet per second. And thus while a

* A velocity sufficient to carry the molecule vertically about eight miles high, if subjected to no resistance excepting gravitation.

molecule of oxygen would undergo about seven thousand million collisions in one second, a molecule of hydrogen among its fellows would undergo about seventeen thousand million collisions per second. It must be observed that the more violent the collisions of the molecules, the less is their tendency toward the cohesion of the liquid, or the adhesion of the solid form.

Probable Size of Molecules.—From various considerations it has been independently estimated by Joseph Loschmidt (1865), by G. Johnstone Stoney (1868), by William Thomson (1870), and by J. Clerk Maxwell (1873), that the effective size of the molecule is probably not smaller than the thousand-millionth of an inch, nor larger than three or four times this dimension; which is about the twenty-thousandth of a medium wave-length of light. Small as this dimension is, we may reflect that by what may be called the second power of our best microscopes, it would be easily visible,—supposing that light-waves were capable of optical efficiency at this degree of subdivision and amplification.

These estimates of molecular distances and magnitudes are of course but rough approximations; but they indicate at least the order of magnitude of very real things and agencies; and accepting them as probable, we may “compare small things with great” by saying that were the planet Venus brought within a distance from our Earth about one and a half times that of the Moon, this might represent the relative mean distance of two molecules of our atmosphere; at which separation (about fifty times their own diameters), they would probably count less than twenty million to the inch. In like manner the distance of Venus from our Earth at conjunction (as during the approaching transit of next Wednesday) would be relatively comparable to the length of a mean excursion of the molecules;—some 3,000 times their diameter. While a few of their longest free excursions would be comparable to the flight of the same planet if carried from the Earth to beyond the orbit of Neptune.

The Relation of Molecular and Atomic Motions.—Returning again from this survey of molecular kinetics to the undulatory theory of light and heat, we may say that the true physical relation of radiation to conduction was first disclosed by the analytic spectrum,—that marvellous instrumentality which physics has presented to her

daughter chemistry, as the most subtle and delicate of all her reagents. From this method of observation we have learned that each of the elements when its molecules are shocked, rings out its own peculiar series of oscillations, as if by specially adjusted tuning-forks, each responsive only to the groupings of its own established periodicities. Newton first taught us that definite refrangibility in the spectrum signifies simply definite periodicity; and he also computed the data which determine the values of these periodicities.*

The known wave-lengths of different colored light divided by their known velocity of propagation, give us the inconceivable rapidity of from 390 to 750 billions per second,† as the number of atomic impulses transmitted by the æther and appreciated by the eye. Although this compass is somewhat less than an "octave," the entire range of the visible and invisible spectrum comprises more than three octaves. This extraordinary rate of vibration, no less than its remarkable uniformity, sufficiently establishes the fact that the motions of the *molecule* ceaselessly varying in velocity, and wholly irregular in length and frequency of excursion, take no part whatever in producing ætherial undulations. It is only to the constituent parts or ultimate *atoms* of the flying molecule that the rhyth-

* NEWTON'S *Optics*. 1704: book II, part I, obs. 6. When shortly after his election to the Royal Society, Newton in a letter to the Secretary—Henry Oldenburg, (dated January 18, 1672,) proposed to offer a communication to that Society respecting his optical analysis, he spoke of it as "being the oddest if not the most considerable detection which hath hitherto been made in the operations of nature." (BIRCH'S *History of the Royal Society*. 1757: vol. III, p. 5.) Although a century and a quarter elapsed before the spectral lines were first detected by W. H. WOLLASTON, (*Phil. Trans. Roy. Soc.* June 24, 1802: vol. XCII, p. 365;) Newton was fully aware of the necessity of employing a very small hole or luminous image for obtaining a pure spectrum, and he pointed out that a narrow slit is still better; "for if this hole be an inch or two long, and but a tenth or a twentieth part of an inch broad, or narrower, the light of the image will be as simple as before, or simpler, and the image will become much broader." (*Optics*: book I, prop. IV.) For delicate observations Newton appears to have been compelled to rely on the services of an assistant; and thus he missed the consummation of his "oddest and most considerable detection of nature's operations"—the spectroscope.

† A *billion* (as is sufficiently indicated by the term itself) is the "second power of a million;" not (as is commonly taught in school-book numeration) the *third* power of a thousand, or the *second* power of an impossible number;—a surd

mic motions generating radiant light and heat must be referred. We may thus picture to ourselves the monochromatic lines of the spectrum as exhibiting a second order of occult or insensible kinetics, in quality and range as different from and as much below the kinetics of the molecule, as this differs from and is below the kinetics of tangible masses.

The Origin of Atomic Motions.—With regard to the nature and origin of the atomic motions, it appears tolerably clear that they are primarily derived from the shocks of the molecules or systems of which they are the components; and that there is at every molecular collision a transfer or exchange of energy tending to equalize the internal momentum of pulsation with the external momentum of translation. The *primum mobile* is therefore the falling together of molecules under the influence either of gravitation, or of chemical affinity. While it is difficult to realize the precise manner in which molecular and atomic motions are re-distributed during the brief instants of impact, it appears in the highest degree probable that the atoms describe *elliptical orbits*, which may become circular, but never rectilinear. Were the atomic motions mere oscillations, it would appear unavoidable that under the stress of special impacts, some of them must occasionally be detached,—as in the case of molecular evaporation. But the *ultimate* molecule is unchangeable and “indivisible:”—held together in bonds incomparably stronger than those of hardest steel. And the loss of an atom may be regarded as an impossible catastrophe. Moreover, from the utter irregularity of direction in molecular encounters, obliquity of impact on the rapidly changing atoms, would appear almost a necessity: and hence would result as necessarily—elliptical paths of excursion.

In this constant play of atoms derived from repeated collisions, we must believe that these atoms are whirled in ever varying *rotations*—simultaneously with their orbital revolutions; but as these double motions form but parts of their common fund of kinetic energy, it is not probable that any special phenomena will ever distinctly reveal such axial motions;—unless indeed it be hereafter shown that *polarity* is the resultant of concerted directions of rotational or orbital axes, or of both.

The Amplitude of Atomic Orbits.—Of the actual or relative diameters of these orbits we are as ignorant as we are of the sizes

of the atoms themselves. We may assume the amplitudes of the ætherial waves at their origin, to be a faithful transcript of those of the atomic excursions which generate them: and we must conclude the latter to be—even in the velocities of the highest incandescence, extremely small fractions of the length of the resulting waves. For although the amplitude of the atomic orbit represents but the square root of the brilliancy, we may reflect that this latter form of energy presents an enormous range of variation. The light from Sirius—for example, supposing it to be in time twenty years in reaching us,—has but $1 \div 1,315,000$ part of the amplitude of terrestrial sun-light; the amplitude being inversely as the distance travelled.* And there are among the visible stars doubtless some a thousand times more distant yet than Sirius.

According to the estimates of Wollaston, and of the younger Herschel, lights may vary in brilliancy forty thousand million times, representing a difference of amplitude of two hundred thousand times. To suggest some approximate idea of the form of such ætherial waves, we may liken them to earthquake waves transmitted across the surface of the ocean at the rate of six miles in a minute, which, while leaving on the tide-gage their registered amplitude of 15 inches, have for their length 150 miles: being accurately measurable waves presenting the ratio of one inch to ten miles.†

*As the bright sun Sirius is considerably larger than our sun, and probably intrinsically brighter as well, the figure 1,315,000 (representing its distance in units of sun-distance) would be somewhat reduced as a measure of relative wave-amplitude. If the intrinsic splendor of the two suns be the same, the distant one has about 64 times the surface, or eight times the diameter of our own. The probability of greater density in the former—from greater mass,—is offset by the probability of correspondingly higher temperature. Hence assuming the mean densities to be nearly the same, the gravitative pressure of equal gaseous masses on the photosphere of Sirius, would probably be in the neighborhood of eight times that upon our sun, or some 200 times that upon the surface of our earth.

† The earthquake which destroyed the city of Simoda, in Japan, in December, 1854, generated such a system of waves, which crossing the Pacific Ocean, over a distance of 4,500 miles, in the time of 12 hours and 36 minutes, left their record on the tide-gages of the Coast Survey, at San Francisco, as having a maximum amplitude of 18 inches. The height of the ocean wave at its origin was, of course, much greater than this. (*Smithsonian Report* for 1874: pp. 216, 217.—A Lecture "On Tides," by Prof. J. E. HILGARD, (at present Supt. of Coast Survey,) delivered before

Smallness of Atoms.—The extreme minuteness of the atoms is evidenced not alone by the necessary limitations of their orbital excursions under ordinary conditions, and by their inconceivable rapidity of oscillation, but even still more strikingly by the vast number of molecules which may be chemically combined and compacted within the volume of an elementary molecule,—still observing the law of Avogadro.

From such considerations we may infer that the dimensions of the ultimate atoms are probably as much below that of the composite molecule, as this is beneath a visible magnitude: or in other words, that were the molecule an object to be seen, the highest power of our best microscopes would utterly fail to detect its constituent atoms.

The Constancy of the Atomic Periods.—We have learned from the fixity of the spectral lines (whether luminous or dark) that what may be called the tones or pitches of these resonant particles are very accurately maintained through an enormous range of amplitude; that is, that the respective periods of the atomic orbits (infinitesimally brief as they appear to our slow-moving thoughts) are quite unaffected by their radii, or their rates of velocity. The evidence of these uniformities of period in descending temperatures is found in the stability of gaseous absorption lines under all degrees of cold producible; these lines remaining dark when taking up the motion of the incandescent back-ground, simply because the amplitude of the oscillation is not sufficient on the whole to impress our sense of vision. And although at very high temperatures both the number and the distinctness of the spectral lines may be considerably affected, their position (as long as visible) is not at all disturbed. That new lines should appear at increasing temperatures is not surprising, since in every case a certain width of atomic play is required to affect the eye. But that under such circumstances pre-existing lines should disappear,—as has been established by the researches of Dr. J. Plücker and Dr. J. W. Hittorf,*—so

the American Institute, Jan. 27, 1871.) It is instructive to reflect that a wave line of this order (representing an ætherial undulation)—executed by the most skillful draftsman or engraver, on any scale whatever, or with any microscopic appliances, could not be distinguished by any process of direct instrumental measurement or verification from a perfectly straight line.

**Phil. Trans. Roy. Soc.* Memoir read March 3, 1864: vol. CLV, pp. 1–29.

as to produce an entirely different spectrum, is not so easily explained. The suggestion of a disruption or disassociation of the atomic flight by centrifugal force is negated by the fact of perfect restoration of the orbit under uniform conditions. Nor does the hypothesis of a resolution of the elementary molecules into still more elementary types, (which seems to have gained some favor,) render the physical conception of the phenomena in any respect more simple. In particular cases a precise equalization of the energies of emission, and of absorption in surrounding heated gas, might effect a neutralization and complete obliteration of one or more of the lines. And it is conceivable that a certain increase of amplitude in the ætherial wave may (as in the case of its length) cease to be recognized by the optic nerves.

The law of Atomic Orbits.—The conception being thus presented to us—of a particle moving in an elliptical or circular orbit of constant period, irrespective of the length of the radius-vector, or of the velocity, (a condition so wholly unlike the gravitative orbits of planets, observing the laws of Kepler,) what is the dynamic interpretation of such a system? This problem has been anticipated by the genius of Newton, who in his *Mathematical Principles of Natural Philosophy* has demonstrated the *imaginary* case,—“if the periodic times are equal, (and the velocities therefore as the radii,) the *centripetal* forces will also be as the radii.”* A law of force *increasing* directly with the distance (as in the extension of an india-rubber, or of a helical steel wire spring,) is undoubtedly a very remarkable one: but whatever its range of action, it will manifestly within that range, secure the atom from all possibility of detachment.

From the perfect uniformity both of chemical and of spectroscopic indications, whether in the smallest or the largest mass of molecules,—from whatever source obtained, we are forced to conclude that the molecules of any simple gas are absolutely similar. Whether we analyze a drop of petroleum or distill an insect or a

* *Newton's Principia*. 1687: book I, sect. II, prop. 4, corol. 3. A very beautiful illustration of this orbit is presented by the conical pendulum, when the length of the suspension is very great relatively to the ranges of excursion of the ball, so that an ellipse or different circular orbits shall lie sensibly in the same plane. Another similar example is furnished by the orbits of the balls of a parabolic “governor.”

plant, whether we decompose water from the Indian ocean or from Arctic snow-flake, whether we inspect with curious eye the light from sun, or star, or from remotest nebulæ at opposite confines of the heavens, we find in the spectrum of hydrogen the same fixed lines;—assuring us that these are truly the reverberations of periods incessantly repeated alike in every molecule of this particular element.* Taking this—the lightest of all known molecules, (Prout's fundamental unit of chemical equivalency,) we have within the single molecule the widely separated lines of four distinct periodicities, or atomic orbits:—the red line "C" (α) of 456 billion revolutions per second,—the greenish blue line "F" (β) of 615 billion revolutions,—the blue line near "G" (γ) of 689 billion revolutions, and the violet line "h" (δ) of 729 billion revolutions. As no form of either reciprocating or orbital movement could possibly be maintained without an equal and opposite re-action, there must necessarily exist here *at least* eight independent atoms. But it seems wholly improbable that each of these systems of motion should comprise but a single couple of atoms: and it is still more improbable that either these periods, or even the numerous additional ones disclosed in the secondary spectrum of hydrogen, represent all the atomic motions within its molecule, in view of the necessary imperfection of the optical record, and the fact that this embraces less than the third, and possibly not more than one-fourth of the whole actinic spectrum.

Physical Complexity of the Molecule.—We are therefore justified in believing that the most elementary of chemical molecules is a wonderfully complex system, comprising an unknown number of constituent units, held together by dynamic bonds whose nature we can neither guess nor conceive; and thus the atom of Newton and of Dalton has been carried downward far beyond the horizon of action at which they had imagined it—probably even to a second order of diminished magnitude.

The relations between the translatory motion of the integral gase-

* "The same kind of molecule—say that of hydrogen—has the same set of periods of vibration,—whether we procure the hydrogen from water, from coal, or from meteoric iron; and light having the same set of periods of vibration comes to us from the Sun, from Sirius, and from Arcturus." J. CLERK MAXWELL. (*Encyclopæd. Brit.* 1875: art. "Atom," vol. III, p. 48.)

ous molecule and the internal revolutions about its center of inertia present a new difficulty of conception as to the constitution and action of the ætherial medium. For while the molecule (a mere cluster of atoms) is supposed to be flying freely about without obstruction or retardation, (in order to fulfil the laws of Charles, and of Boyle and Mariotte,) the individual atoms themselves experience a very considerable resistance to their revolutions;—the precise measure of which resistance is the kinetic energy absorbed and expended by ætherial undulations. And so it results conversely, that if the motion of the æther-waves exceeds that of the molecular atoms exposed to their action, the difference of momentum is taken up by the latter, and through exchanges at molecular encounters is equalized by corresponding increments of velocity in the molecules themselves. Such is the process in all terrestrial heating by solar radiation. And this brings directly to view one important distinction between heat and light,—to wit, that while both are *radiated* in precisely the same manner, “conduction” has no existence in optical action. The only approach to any such effect in light, is found in the obscure and puzzling phenomena of fluorescence and phosphorescence, and of animal luminosity. In the case of *heat* we may have a transfer by radiation—always the result of atomic motion, by conduction—always the result of molecular motion, or by convection—always the result of mass motion.

During the time of a mean free excursion of gaseous molecules at the temperature of incandescence, the atomic periods would permit from ten to twenty thousand revolutions. But from the great amount of energy absorbed by the æther it does not appear probable that any considerable portion of such orbital movement can continue throughout the interval of a mean free path. If then it be true that in a majority of the molecular excursions the whole internal atomic motion is absorbed and destroyed, to be renewed again only by the succeeding collisions, there is a constant drain upon the molecular momentum; a condition which must alike prevail, however low may be the temperature of the gas. While there is thus a constant tendency to equalization of the orbital atomic momentum and the rectilinear molecular momentum, the total kinetic energy of the former has been estimated at not more than from two-thirds to three-fourths of the kinetic energy of the latter.

It is in the gaseous spectrum alone—that is, in the atomic motions of discrete molecules, that perfect uniformity of period, or as we

may call it, perfect purity of optical tone is to be observed. With any considerable compression of a gas, that is, with any great crowding together of the molecules and shortening of their mean free excursions, whereby the increased frequency of collision is constantly disturbing the atomic orbits before their motions can be fully absorbed by the æther, there will result a momentary hastening or retarding of the normal periods, giving to the spectral lines an increased breadth or wider range of refrangibility. And when the condensation reaches that of the "liquid" or "solid" condition, preventing all free excursion, the incessant agitation of the atoms results in a universal clang or optical "noise," in which all uniformity of period seems lost, and perturbations of all possible degrees present us with the discord and confusion of a perfectly continuous spectrum.*

The Chemist has taught us that in numerous cases the normal molecule is divided into sub-molecules. Thus the relations of the compounds of arsenic, as well as of those of phosphorus, indicate the composition by half molecules of these elements; the ratios of the so-called "sesqui-salts" point to the same result; the allotropic condition of oxygen—called ozone—is formulated as having the equivalency of one and a half molecules; one molecule of aqueous vapor (and therefore of water) consists of one molecule of hydrogen and a half molecule of oxygen; two molecules of ammonia are resolved into three equal molecules of hydrogen and one of nitrogen; and a single molecule of hydrogen united with a single one of chlorine will form two molecules of hydrochloric acid,—each containing an equal division of the two constituents. Although this dichotomy of the molecule is suggestive of binary systems in some way specially linked together and at the same time susceptible of various re-arrangements, yet the fact remains that these divided molecules are still extremely complex physical systems,—apparently identical in constitution and construction, and therefore undistinguishable from each other. The Chemist however adhering too literally to the phrase of Dalton, has neglected the obvious import

*J. CLERK MAXWELL has felicitously compared the atomic oscillations producing a continuous spectrum, to the clang of a bell "on which innumerable hammers are continually plying their strokes all out of time, [when] the sound will become a mere noise in which no musical note can be distinguished." (*Encyclopæd. Brit.* 1875: art. "Atom:" vol. II, p. 43.)

of the spectral lines, and speaks familiarly of the *diatomic* molecule.* It is true that the "atom" is properly a physical and not a chemical unit, since it can never be reached by any possible reactions of affinity or of decomposition. But if the term is to be still retained in chemical nomenclature, it should always be understood in its merely etymological sense of the "undivided," and not in its more popular sense of the un-compounded.

3. *The Fallacy of Kinematic Theories.*

After this rather labored effort to approximate to some definite conception of the physical nature of the two types of invisible or elementary motion—displayed in the atomic revolutions or oscillations generating radiant undulations of the æther, and in the molecular flights and encounters generating the thermo-dynamic pressures of gaseous fluids,—let us consider what countenance these forms of motion may be supposed to lend to a kinematic theory of universal force.

It is important here to notice that by experiments on the sensible vibrations of bodies,—as of tuning-forks and pneumatic diaphragms,—translatory motions of approach and recession have been produced in light bodies. The "attractions" or "repulsions" have been shown to depend on the amplitudes of the oscillation, and the ratio of the wave-lengths to the surfaces of action; as also on the symmetrical concurrence or reversal of the phases of vibration in two confronting systems.†

* Prof. GEORGE F. BARKER in his excellent presidential address before the Chemical Section of the American Association at Buffalo, on the theme—"The Molecule and the Atom," referring to the constitution of hydrochloric acid, repeats the common view: "hence a molecule of hydrogen is composed of two atoms." (*Proceed. Am. Assoc.* August, 1876: p. 95.)

† Dr. JULES GUYOT. *Des Mouvements de l'Air et des Pressions de l'Air en Mouvement.* 8vo. Paris, 1835.

Prof. FREDERICK GUTHRIE. "On Approach caused by Vibration." *L. E. D. Phil. Mag.* Nov. 1870: vol. XL, p. 354. (From his tuning-fork experiments, the author ventures the bold and startling induction: "In mechanics—in nature—there is no such thing as a pulling force.")

Prof. C. A. BIERKNES of Christiania, Norway. Hydro-dynamic experi-

Irrelevancy of a Vibratory Hypothesis.—The first remark that occurs to a thoughtful student of these well-known phenomena of hydro-dynamics, (upon which narrow basis some enthusiasts have erected so wide a framework of induction,) is that between these resultant motions and any actions traceable in molecular physics,—(unless possibly in particular habitudes of electricity and magnetism,) there is not even a rough analogy. And the next and most obvious suggestion is that the absolute precedent condition of any reciprocating action whatever is the presence of the very qualities—*cohesion* and *elasticity*—for the production of which such reciprocating action is invoked. The essential powers and characteristics by which alone either atomic revolutions or molecular impacts are for an instant rendered possible, are the inherence of never-slumbering forces of attraction and repulsion. A vibratory particle (assumed by the kinematist for the avoidance of incomprehensible attributes,) is itself the most astounding—the most unrealizable in scientific thought, of all physical concepts. No atom can perform an oscillation or a revolution, or follow any other path than a straight line—excepting under the coercion of other atoms attracting and repelling. The first law of motion is that of perfect continuity both in amount and in direction. A shuttlecock rebounding in the empty air, would not be more conspicuously a dynamic solecism and impossibility than the kinematist's "vibratory particle."

Those therefore who in their backward search of causation would assign the origin of force to some incomprehensible æther action, have no more warrant from experience, induction, or reason, than those less cultured philosophers who taking "the unknown for the wonderful" habitually refer each unfamiliar phenomenon (with easy faith)—to "electricity."*

ments on vibration. *Nature*. Aug. 18, 1881: vol. xxiv, p. 360; and Jan. 19, 1882: vol. xxv, pp. 272, 273.

Also a modification of the experiments of Prof. Bierknes, by Mr. AUGUSTUS STROH: (in air instead of in water.) *Nature*. June 8, 1882: vol. xxvi, p. 134.

* "There are not wanting those who appear very much disposed to say that the conception of *force* itself—as part and parcel of the system of the material universe—is superfluous and therefore illogical. - - - Having come to regard heat, light, electricity, as modes of motion, they seem to consider force itself as included in the same category, and think there is

Instability of a Vibratory Hypothesis.—But the kinematic embarrassment is not concluded here. Supposing the marvellous feat accomplished of effecting a rotatory resilience which should simulate in direction and amount the facts of observation, how far would such accordance justify its acceptance as the true and sufficient account of the molecular behavior, in the light of the great established principle of the conservation of energy? As a necessary corollary of this great generalization we know that every system of atomic or molecular oscillation, undulation, and impact, is directly amenable to material disturbance and to the precise mechanical equivalents of kinetic deflection, arrest, and neutralization. But as regards the fundamental qualities of atomic or molecular attractions, repulsions, and elasticities, no such disturbance, or aberration, or interference, is for an instant possible. And these fundamental qualities are persistent, and permanent, as well as unchanging. Hence the countless balls sustained in place by countless fountains, must never be permitted to decline or swerve from their required positions. Every bent spring, every loaded beam, every sustaining rope and chain and cable must therefore have expended upon it a ceaseless rain and battery of impact or of wave propulsion. Nay every solid, every liquid, must be held in its tenacious consistency by the external coercion of a never resting dynamic bombardment. In what manner is the inexhaustible supply of kinetic energy supposed to be obtained? What is its source?—and where is its escape? Why is it that the incessant and violent collisions brought into play

‘reason to believe that it depends on the diffusion of highly attenuated matter through space.’” Sir JOHN HERSCHEL. (“On the Origin of Force.” *Fortnightly Review*. July 1, 1865: vol. I, p. 436. And *Familiar Lectures*, [etc.] 12mo. London, 1866: art. XII, p. 462.)

The learned physical professor in the University of Edinburgh sees “reason to believe that *force* depends upon the immediate action of highly attenuated matter diffused throughout space.” (*North British Review*. February, 1864: vol. XL, p. 22,—of Am. edition. And Prof. P. G. TAIT’s *Sketch of Thermo-dynamics*. 8vo. Edinburgh, 1868: chap. I, sect. 3, p. 2.)

And the no less learned physical professor in the University of Cambridge, thinking it irrational to ascribe the occult quality of *elasticity* to any sensible molecule, finds no difficulty in relegating this property to the æther. (*L. E. D. Phil. Mag.* June, 1866: vol. XXXI, pp. 468, 469. And Prof. J. CHALLIS’s *Principles of Mathematics and Physics*. 8vo. Cambridge, 1869: pp. 316, 358, and 436.)

under this dynasty of percussion, do not speedily raise the temperature of all coherent bodies to a fierce and glowing heat?*

And this brings us face to face with the great radical—incommensurable difference between “force” and *energy*,—that the function of the former is attended with no expenditure, and is capable of no exhaustion. The truth of this bold asseveration has been tested again and again by every expedient which the most skillful and ingenious kinematists have been able to devise for its question, without the suspicion of impeachment; and it remains to-day, one of our strongest and best assured inductions.

On this broad platform rests the issue between kinematism and dynamism,—that the former inevitably contravenes and destroys that bulwark of modern physics—the *conservation of energy*; while the latter is its only support and its necessary foundation. Without the indestructible—unwasting—tensions of molecular attraction and repulsion, it lies beyond the scope of human ingenuity to devise or imagine a conservative system.

The fundamental—the inherent and incurable weakness of every attempt to supersede “force” by motion is betrayed in this,—the inadmissible supposition of a world held together only by the infinite expenditure of *work*, for whose existence no provision is devised, and for whose maintenance no motor can be suggested or conceived.†

* Referring to the steady maintenance of material tensions by supposed ætherial motions or vortices, J. CLERK MAXWELL truly remarks: “No theory of the constitution of the ether has yet been invented which will account for such a system of molecular vortices being maintained for an indefinite time without their energy being gradually dissipated into that irregular agitation of the medium which in ordinary media is called heat.” (*Encyclopædia Britannica*. 9th ed. 1878: art. “Ether:” vol. VIII, p. 572.)

† “Taking such a system in its entirety (where force exists not), there is no possibility of its reproduction. There is therefore a necessary and unceasing drain on the *vis viva* of such a system. Everything which constitutes an event, whatever its nature, exhausts some portion of the original stock. Such a system has no vitality. It feeds upon itself and has no restorative power.” Sir JOHN HERSCHEL, (“On the origin of Force.”—*Fortnightly Review*. July 1, 1865: vol. I, p. 437. And *Familiar Lectures*, [etc.] 1866: art. XII, p. 465.)

“It is remarkable” observes J. CLERK MAXWELL, “that of the three hypotheses which go some way toward a physical explanation of gravitation, every one involves a constant expenditure of work.” (*Encyclopæd. Brit.* 9th ed. 1875: art. “Attraction:” vol. III, p. 65.)

It is the inversion of the sequence taught us by all sufficiently observant experience, that motion of any kind or form is ever the product of force, and can never be its parent.

Inadequacy of a Vibratory Hypothesis.—But after all this lavish exercise of creative power and ingenuity,—this prodigal expenditure of kinetic energy,—how surprising to find the notable invention wholly incompetent to produce the observed phenomena. Cohesive force (for example) apparently incapable of exerting any attractive power whatever beyond the range of a single layer of molecules, that is beyond the distance of perhaps the five hundred millionth of an inch from its center of action, yet exercises for an exceedingly small space within that distance a holding strength many thousands of times greater than the all-pervading power of gravitation. By what form of undulation, oscillation, or impulsion, shall we represent the tenacity of a steel wire sustaining a pull of 300,000 pounds to the square inch beyond the limits of perhaps the thousand-millionth of an inch between its molecules, yet exerting within that limit an insuperable repulsion, and again at double the distance another range of repulsion, so far resisting all human efforts, that the nicest and closest approximation of the severed ends of the wire shall fail to develop the attraction of an ounce or single grain? By what form of partial differential equation, shall this sudden and absolute discontinuity of function be expounded? Nay rather, by what hallucination of metaphysical assumption have intelligent men been induced to waste useful time and ink and paper, on the chase of the *ignis-fatuus* of cohesive undulation or percussion?

The Authority of "Sensible" Impressions.—But it is insisted that "the principle of deriving fundamental conceptions from the indications of the senses does not admit of regarding any force varying with distance as an essential quality of matter, because according

* Prof. CHALLIS thinks "the ultimate atoms of glass are kept asunder by the repulsion of ætherial undulations which have their origin at individual atoms," and "it may be presumed that this atomic repulsion is attributable to undulations incomparably smaller than those which cause the sensation of light." (*Principles of Mathematics and Physics*. 1869: p. 456.) But the luminiferous vibrations are themselves *atomic*. What lower order of atom is then to be appealed to in support of this fanciful and inept hypothesis?

to that principle we must in seeking for the simplest idea of physical force have regard to the sense of *touch*."* Let us inquire then what is taught us by tactile experience with regard to the philosophy of physical contact. In the celebrated experiment by which Newton first measured the wave-lengths of light from the colored rings which yet bear his name, he found that on placing a piece of clean plate glass upon the convex surface of a large lens, a very considerable pressure was required to exhaust the series of outcoming interference fringes and to exhibit the central black spot. Professor Robison estimated that a pressure of at least one thousand pounds to the square inch was necessary to effect this approach to a mathematical contact between the two glasses.† And yet even with this very close and perfect physical contact it is shown that at the first appearance of the black spot between the glasses, they are still separated from actual or mathematical contact by the space of the 250,000th of an inch.

Material Contact not Absolute.—Supposing it were desired to directly communicate a push or a pull through the distance of seven miles, a perfectly straight steel bar (properly supported on friction rollers through that space) would probably be as efficient a *mechanical* means for the purpose as could well be suggested. And yet the blow of a suitably heavy hammer struck upon one of its ends would

* Prof. JAMES CHALLIS. *Principles of Mathematics and Physics*. 1869: p. 358.

† *A System of Mechanical Philosophy*. By Prof. JOHN ROBISON: vol. I, sect. 241, p. 250. Dr. YOUNG remarks on this: "Hence it is obvious that whenever two pieces of glass strike each other without exerting a pressure equal to a thousand pounds on a square inch, they may effect each other's motion without actually coming into contact. Some persons might perhaps be disposed to attribute this repulsion to the elasticity of particles of air adhering to the glass, but I have found that the experiment succeeds equally well in the vacuum of an air-pump. We must therefore be contented to acknowledge our total ignorance of the intimate nature of forces of every kind." (*Lectures on Natural Philosophy*. 2 vols. 4to. London, 1807: lect. III: vol. I, p. 28.) And Prof. J. CLERK MAXWELL says to the same effect: "We have no evidence that real contact ever takes place between two bodies, and in fact when bodies are pressed against each other and in apparent contact, we may sometimes actually measure the distance between them, as when one piece of glass is laid on another, in which case a considerable pressure must be applied to bring the surfaces near enough

require very nearly two seconds for its transmission and delivery at the opposite end. Or if we reduce our steel punch to the more manageable length of (let us say) one foot, then the blow received by it from a hammer, and the blow given out by it at the other end, will be separated by the interval of the 18,000th part of a second. Assuming the actual approach of the hammer face to the end of the steel punch at the instant of impact to be the millionth of an inch, we may even compute the interval of time elapsing between the delivery of the blow by the hammer and its reception by the steel punch, at the $1 \div 216\,000,000\,000$ of a second; an interval of time real enough and long enough to permit the atoms of the iron molecules to execute from 1800 to 3200 of their normal oscillations or orbital revolutions. By thus considering what is really signified by physical contact and impact, we find it to be something quite different from what the kinematist would suggest by his appeals to "the sense of touch."

The unlucky boy when struck in the face with a ball, or wounded in his finger with his jack-knife, may well refuse to be comforted by the assurance that neither the ball which bruised his face, nor the blade which penetrated and severed the capillary vessels of his finger, ever approached within the millionth of an inch of his flesh, or probably within double that distance from it. But the philosopher who aspires to construct a theory of universal force from the inductions of experience, should at least sufficiently develop his intellectual vision to avoid accepting coarse and external resemblances as evidences of co-ordinated derivation, or adopting the unanalyzed impressions of unobservant consciousness as the revelations of axiomatic truth.

Action at a Distance.—But here our investigation is undermining the very corner-stone of the kinematic system,—the repudiation of all static energy, the alleged fundamental absurdity of any mechanical action at a distance. That "a thing can no more act *where it is not* than *when it is not*," is a plain dictum of common-sense.* Even the provisional admission of such a supposition is

to show the black spot of Newton's rings, which indicates a distance of about a ten-thousandth of a millimeter." (*Encyclopædia Britannica*. 9th ed. 1875: art. "Attraction:" vol. III, p. 63.)

* Prof. JAMES CROLL believes that "No principle will ever be generally received that stands in opposition to the old adage* 'A thing cannot act

in violation of the canons of sound thought, and is contradictory of one of the most obvious aphorisms of logical metaphysics. Whatever our refinements as to the real nature of physical contact (it is said), this action is none the less a fact of constant and familiar occurrence, and is the actual method of kinetic transference manifested to our every-day observation. If we wish to give a billiard ball a definite motion in a specific direction, we do not whistle to the ball, or attempt to "psychologize" it; we strike it with a cue. Is it conceivable that "mere brute matter" should be more "spiritual" than man himself?

As these popular and taking propositions involve purely a question of physical fact, their truth can never be decided by any introspections of the consciousness, by any deductions from the "*ego cogito*," or by any disquisitions on "the theory of conception." As a question of fact, the final settlement of the nature of material action is to be reached only by the converging inductions of a critical *experience* (aided and enlightened by every expedient of refined investigation), and by the necessary inferences from such experience. It is very certain that a material body must exert its action—either at *some* distance, or at *no* distance, that is by absolute and perfect contact. Have we at present the means of intelligently probing this sharply defined issue?*

Action at no Distance.—It is a well-established principle, or rather fact, of dynamics that finite time is required for the production of

where it is not.''" (*L. E. D. Phil. Mag.* December, 1867: vol. XXXIV, p. 450.) And GEORGE HENRY LEWES is fully persuaded that "Action at a distance (unless understood in the sense of action through unspecified intermediates) is both logically and physically absurd." (*Problems of Life and Mind.* 1875: vol. II, appendix C, p. 484.)

* Dr. OLIVER J. LODGE has remarked: "I venture to think that putting metaphysics entirely on one side we may prove in a perfectly simple and physical manner that it is impossible for two bodies *not* in contact to act directly on each other:" and he defends the position by the argument, that since action and re-action are equal and opposite, and since "work" done upon one body is equal to the "energy" so expended by the opposite body, "the distances must be equal but not opposite; that is, the two bodies must move over precisely the same distance and in the same sense: which practically asserts that they move together and are in contact so long as the action is going on." (*L. E. D. Phil. Mag.* January, 1881: vol. XI, pp. 36, 37.)

any finite velocity, or of any finite change in velocity. Only an infinite force could generate motion instantaneously, and this acting for any finite time would produce an infinite velocity. Now the impact of a moving body upon a body at rest, must occur in the absolute instant of contact. No motion could be transmitted *before* contact, for this would be the chimera—*actio in distans*. No motion could be transmitted *after* contact, for then the impinging body could evidently have no more motion than the body impinged upon. And no motion could be transmitted at the *instant* of contact, for this occupies but an infinitesimal of time. But if no motion could be communicated either before, or at, or after contact, it is very clearly established that no motion whatever could possibly be derived from impact pure and simple. This conclusion—applicable alike to an atom or a planet—remains equally unassailable whatever be the magnitudes of the bodies in action.

We are thus strongly reminded of Zeno's celebrated paradox as to the impossibility of motion. For while the kinematist very positively assures us that action at a distance is a metaphysical impossibility, the dynamist assures us no less positively that action at no distance is a demonstrated physical impossibility.* But if mere kinetic energy cannot be transferred excepting through a vacant

* This position is so forcibly stated by Prof. JOSEPH BAYMA in his able Treatise on Molecular Physics, that a quotation from that work seems here especially appropriate. "Finite velocity cannot be communicated in an indivisible instant, as we have seen. - - - Nor can the demonstration be evaded by having recourse to the *multitude* of points among which the contact would be supposed to take place. For - - - if each individual point of matter only acquires an infinitesimal velocity (*vdv*), the whole multitude will acquire only an infinitesimal velocity; that is, there will be no motion caused at all. Nor can it be said that the motion is communicated by means of a *prolonged* contact. A prolonged contact is impossible unless the velocities have become equal at the very commencement of the contact. Therefore if velocity were communicated by the contact of matter with matter, it would have to be communicated in the very first instant of the contact, not in its prolongation. - - - Therefore *distance* is a necessary condition of the action of matter upon matter. Therefore the contact between the agent and the object acted upon is not material but *virtual*, inasmuch as it is by its active power (*virtus*), not by its matter, that the agent reaches the matter of the object acted upon." (*Molecular Mechanics*. 8vo. London, 1866: book 1, prop. 3, pp. 14, 15.)

space, *à fortiori* must static "force" require distance as the indispensable condition of its action.

So much therefore for the vaunted dictum of "common-sense:" and so much for the antagonistic dictum whose "absurdity is so great that no man who has in philosophical matters a competent faculty of thinking can ever fall into it!"* And this absurd—this incomprehensible—this inconceivable proposition—that matter is capable of acting *only* where it is not, is proved by the incontestible conviction of reason to be a primary and necessary truth: and the wondrous scholastic dogma resisting it—supposed the sacred oracle of a mysterious intuition,—is but the detected impostor of a crude induction.

True meaning of Contact Action.—To confirm however the explicit deductions of mechanical theory by the verifications of actual experience, let us examine more closely the true character of that transmission of energy by impact which to the kinematist appears to furnish so simple and so obvious an explanation of "force." Taking the most elementary example of the *vis a tergo*, let us suppose two precisely similar billiard-balls—*A* and *B*—on the perfectly smooth surface of a frozen lake, *B* at rest, and *A* rolled toward it in the direct line joining their centers of inertia. The familiar result that *A* is brought to rest by the collision, and *B* continues the motion in the same direction prolonged, will be fluently explained by the kinematist as a mere case of conservation, or the persistence of motion,—which evidently passes at the instant of contact directly from *A* to *B*, like an electric charge.

Overlooking—first, the fallacy of a finite velocity passing into a body instantaneously (already controverted), there is a second difficulty, that *motion*—defined as a change of position in a body, or the occupation of successive portions of space by a body,—cannot exist out of the body, cannot therefore pass through the confines of the body. But admitting for the moment both these possibilities,—in the third place, how could the ball *A* part with *all* its motion to

* This inconsiderate utterance of NEWTON in his oft-quoted "third Bentley letter," (Feb. 25, 1693,) was wholly repudiated by him a quarter of a century later, when with a graver wisdom he asked the question: "Have not the small particles of bodies certain powers, virtues, or forces, by which they act at a distance?" (*Optics*. 2d edition. 1717: book III, query 31.) A recantation never cited by the kinematist.

another ball no larger than itself? The two possessing the same inertia, why did not *A* expend just half its motion on collision with *B*, giving the latter its equal share; and thus conserve the original momentum by the double mass moving conjointly with half the velocity? This very simple question—it is safe to affirm—can never be answered by any principles of the science of kinematics.

By the principles of dynamics, these three queries admit of a very satisfactory solution. At the moment of physical contact between the two balls, (there being still an assignable space between them,) their approaching surfaces commence mutually to encroach upon a powerful molecular repulsion crowding back and compressing more closely together vast multitudes of resisting layers of molecules on either side, until their combined pressure gradually absorbs and destroys the momentum of *A*, while simultaneously exerting an equal stress on the inertia of *B*. And thus by the necessary equality of action and re-action, the centers of inertia of the two balls pass successively through the same reversed phases of approach and recession during the brief finite interval of physical contact, attaining a relative velocity of separation precisely equal to that of the encounter: the deformations of the balls, or their compressions, being as the squares of the absorbed velocity, and their energy of recovery being as the square roots of the restored velocity. So far therefore from the original motion of *A* being transferred to *B* (as often loosely stated), it really passes continuously through every stage of decline to actual rest; and a new motion commencing from zero is gradually started in *B*, by the continued application of an elastic pressure, during a finite time.

To take one more example in illustration of the impossibility of action at *no distance*, let us suppose an ivory ball weighing one ounce to be centrally struck while at rest by another ivory ball weighing four ounces, and moving with a velocity of 10 feet per second. If we were to ignore the "occult" force of *elasticity*, and neglect the difficulties already exposed, kinematics would give the simple result of a common velocity of the two balls after impact, of 8 feet per second: 4×10 being equal to 5×8 . But this is not what would happen. We should find instead that the four-ounce ball has its velocity reduced to 6 feet per second, while the one-ounce ball takes up a velocity of 16 feet per second;—just *double* that it should have taken were action at no distance a natural possibility: the latter ball absorbing (so to speak) the whole velocity

and three-fifths more, while the former has expended two-fifths of its original velocity.

Here then is presented a new difficulty on the kinematic theory. In what possible manner can a body moving at a definite rate impart to another body *by simple impact* a velocity considerably higher than that possessed by itself? By kinematics, this question also must remain forever unanswered. By the established principles of dynamics—there being no actual or mathematical contact of the two balls,—the static energy of their combined compressions or repulsions acquired during the time of their physical contact precisely equals the kinetic energy of impact; and consequently on resilience refunds a precisely equal kinetic energy of separation;—to wit, a relative velocity of 10 feet per second.

Impossibility of Action at no Distance.—It turns out therefore when we examine very slightly beneath the surface of “sense information,” that *impulsion* (so perfectly obvious and intelligible to the kinematist) is itself a very notable example of the ultra-sensible and recondite: *—that the vaunted philosophy of “the sense of touch” is no more able to escape from the dominion of the unseen, the hidden, the enigmatical, in causation, than is the dynamism which is held to be so superficial, credulous, and undiscerning.

And this mysterious but necessary principle of all dynamics reaches far back of the imagined cases of corporeal contact in collisions,—even to the intimate structure of the densest material; †

*As acutely remarked by the eminent mathematician—JAMES IVORY: “A little reflection is sufficient to show that in reality we have no clearer notion of *impulse* as the cause of motion, than we have of *attraction*. We can as little give a satisfactory reason why motion should pass out of one body into another on their contact, as we can why one body should begin to move, or have its motion increased, when it is placed near another body. - - - If then we are apt to think that impulse is a clearer physical principle than attraction, there is really no good ground for the distinction; it has its origin in prejudice.” (*Encyclopædia Britannica*. 8th ed. 1854: art. “Attraction:” vol IV, p. 220.)

“When the Newtonians were accused of introducing into philosophy an unknown cause which they termed *attraction*, they justly replied that they knew as much respecting attraction as their opponents did about impulse.” Dr. WILLIAM WHEWELL. (*History of Scientific Ideas*. 1858: book III, chap. IX, sect. 8: vol. I, p. 278.)

† There is good reason to think that absolute contact never takes place in the component parts of the hardest and most compact solid bodies.” JAMES

for it is demonstrable that the component molecules and atoms of the hardest steel are far from being in contact; that carbon molecules have room enough—even when crystal-bound in diamond—to freely execute the oscillations constituting its varying temperature by constant exchanges, and to so alter their relative excursions as to represent the changed specific gravity due to varying temperature.

The conclusion reached, we would wish to express in the most emphatic and unequivocal terms:—that in all nature we have as yet been furnished with no example of absolute contact action;—that “action at no distance” is sheer physical *impossibility*;—that in utter scorn of venerable scholastic axioms, matter is forever incapable of influencing other matter in any manner whatever or in any degree whatever—*excepting* “where it is not!” And thus the paradox of Zeno receives its solution by the thorough confutation of kinematism at every point—inductive or deductive,—theoretical or experimental.

“*Occult Qualities.*”—And now we are fully prepared to encounter the portentous arraignment of having recourse to the witch-craft of magical virtues and to the mystery of “occult qualities.” What then is the precise import of this supposed obnoxious epithet *occult* as applied to material property or quality? A property whose existence is once clearly demonstrated, can scarcely with propriety be characterized as hidden, unknown, or undiscovered.* Rather are

IVORY. (*Encyclopæd. Brit.* 8th ed: vol. IV, p. 220.) The case of simple traction by a “solid” metallic rod can be explained *only*—(as J. CLERK MAXWELL has well stated)—“by the existence of internal forces in its substance” or “between the particles of which the rod is composed, that is between bodies at distances which though small must be finite,” and for these tensions acting through small distances—“we are as little able to account as for the action at any distance, however great.” (*A Treatise on Electricity and Magnetism.* 8vo. 2 vols. 1873: part I, chap. v, sect. 105: vol. I, p. 123.)

* LEIBNITZ in his memorable controversy with NEWTON regarding the authorship of the infinitesimal calculus, took occasion—with a somewhat amusing though ill-tempered irrelevancy, to assail his rival’s *mechanical* philosophy. In a published letter he says: “His philosophy appears to me somewhat strange, and I do not believe that it can ever be established. If all bodies possess gravity, it necessarily follows (however the defenders of the system may speak, and whatever heat they may display), that gravity

these terms applicable to pretended explanations—having no basis in fact or in reason—proffered in the vain hope of avoiding unexpected or undesired inductions. But if the phrase be designed to stigmatize either the absolute cause of original properties or their mode of operation, as obscure, hidden, inexplicable, then the epithet is but the expression of a necessary and universal truth, which may be accepted with entire satisfaction.

On contemplating the backward steps of efficient causation, we find them not only finite in number, but in any case even surprisingly few,—if we neglect the complications of perturbation, and the successions of iteration in time. When we arrive at the primitive efficient cause, (if we accept it as ultimate,) this is by admission and very definition—inexplicable; since any attempt to explain it, necessarily refers it to an antecedent cause, and thus denies it to be ultimate.* Or if this denial be insisted on, then the series of

must be a scholastic *occult quality*, or the effect of a miracle. - - - Nor do I find a vacuum established by the reasons of Mr. Newton, or of his partizans, any more than his pretended ‘universal gravitation,’ or than his ‘atoms.’ No one—unless with very contracted views—can believe either in the vacuum, or in the atoms.”

With equal dignity and cogency, NEWTON replied to this tirade, in a letter dated February 26, 1716, that he was not to be drawn by M. Leibnitz into a dispute which was nothing to the question in hand. “As for philosophy, he colludes in the significations of words, calling those things ‘miracles’ which create no wonder; and those things ‘occult qualities’ whose *causes* are occult, though the qualities themselves be manifest.” (Raphson’s *History of Fluxions*. Also the *Works of Isaac Newton*, edited by Samuel Horsley. 5 vols. quarto. London, 1779–1785: where both letters are given: vol. IV, pp. 596, 598.)

*Says ROGER COTES in his admirable Preface to the *Principia*: “Since causes naturally recede in a continued chain from the more compounded to the more simple, when the most simple is reached no further backward step is possible. Hence an ultimate cause cannot admit of any mechanical explanation; for if it could, it would by that very fact cease to be ultimate. Will you therefore banish ultimate causes by calling them ‘occult?’ Then those immediately depending on such must next alike be banished, and straightway those next following; until relieved from every vestige of a cause, philosophy shall indeed stand purged!” (Newton’s *Principia*. Second edition. 1713. *Preface*.)

Says Sir WILLIAM HAMILTON, “As every effect is only produced by the concurrence of at least two causes, and as these concurrent or co-efficient causes in fact constitute the effect, it follows that the lower we descend in the series of causes, the more complex will be the product; and that the

explanations is necessarily illimitable, and as necessarily beyond the grasp of human comprehension. Do what we will we cannot escape the inexorable logic of fact,—the certainty of conviction that the ultimate must in the nature of things be forever the unintelligible, the inexplicable, the inscrutable;—that (paradoxical as it may sound) no explanation can be accounted final until it has been pursued backward to the unexplainable.

And this furnishes an additional objection to the kinematic scheme,—that it leaves a vast domain—a phantasmagoria of inconsequent motions—still to be explained;—that however irrational or inexplicable its last postulate, it does not attain to that simplicity of inherent, inscrutable, attribute of power, which must ever be the test of final resolution.

He who supposes, therefore, “that the information of the senses is adequate (with the aid of mathematical reasoning) to explain phenomena of *all kinds*,” who refuses to admit “that there are physical operations which are—and ever will be incomprehensible by us,” betrays a very imperfect idea—no less of the impassable limitations of finite intellect, than of the fathomless profundity of nature’s system.* He who thinks that by formally repudiating the mysterious, and confidently discarding the unknown, he thereby

higher we ascend, it will be the more simple. - - - And as each step in the procedure carries us from the more complex to the more simple, and consequently nearer to unity, we at last arrive at that unity itself,—at that ultimate cause, which as ultimate cannot again be conceived as an effect.” (*Lectures on Metaphysics*: lect. III, p. 42, of Am. edition. 8vo. Boston, 1859.)

Says HERBERT SPENCER, “It obviously follows that the most general truth not admitting of inclusion in any other, does not admit of interpretation. Of necessity therefore, explanation must eventually bring us down to the inexplicable. The deepest truth which we can get at must be unaccountable.” (*First Principles*. 2d edition, 1869: part I, chap. 4, p. 73.)

*Prof. JAMES CHALLIS, in an essay “On the Fundamental Ideas of Matter and Force in Theoretical Physics,” maintains that when there is no apparent contact between bodies, “it must still be concluded that the pressing body although invisible, exists,—unless we are prepared to admit that there are physical operations which are and ever will be incomprehensible by us. This admission is incompatible with the principles of the philosophy I am advocating, which assume that the information of the senses is adequate—with the aid of mathematical reasoning—to explain phenomena of all kinds.” *L. E. D. Phil. Mag.* June, 1866: vol. XXXI, p. 467.)

abolishes or in the slightest degree diminishes his insuperable nescience of the ultimate,—but imitates the ostrich, and deludes himself.*

When men not yet emancipated from the realism of mediæval scholasticism began to turn their attention from the dreams of ontology to the actualities of sensible phenomena, it is scarcely to be wondered at that to every abstracted property of things around them, they gave “a local habitation and a name;” until the banished Nereids and Oreads, the Naiads and Dryads, the Sylphs and Gnomes, of poetic fable, were re-habilitated in a very pantheon of “occult qualities.” When in a later age a larger observation and a more mathematical logic replaced these entities by more mechanical conceptions, it is perhaps as little surprising—in the momentum of re-action—that the term “occult quality” should become a shibboleth of aversion, of apprehension, and of opprobrium, the imputation of which should disturb the philosophy of even a Newton. But that we of the nineteenth century,—capable of understanding and of estimating at their approximate value the limits of these oscillations of intellectual kinetics, should be equally the timid servitors of a vocabulary—seems less excusable. Whether the intended reproach be applied to the *existence* of demonstrated qualities, or more critically to their *cause* and mode of action, is practically of little consequence. Let it be frankly avowed,—let it be boldly heralded, that in their *essence* all the primal qualities of matter are “occult;” and must of necessity forever remain so. Let it be recognized—with a fitting modesty—that this veil of Isis shall never be removed by mortal hands.†

*The continental philosophers of the seventeenth century desired not only to abolish the fanciful qualities of bodies invented by their predecessors, but (as has been well said) “they tried also to abolish their own ignorance of the causes of the sensible qualities of matter. They would not have occult *causes*, and Leibnitz plainly confounds occult quality with occult cause. But it is needless to dwell upon the fact that the ultimate causes of all qualities are occult.” *English Cyclopædia*—Division of *Arts and Sciences*: art. “Attraction:” vol. I, col. 739.)

† *Τὸν ἐμὸν πέπλον οὐδείς πω θνητὸς ἀπεχάλυψε*.—Inscription in the temple of Athene-Isis, at Sais on the Nile. “My veil no mortal ever withdrew.”

“In bodies we see only their figures and colors, [etc.] - - - but their inward *substances* are not to be known either by our senses, or by any reflex

The Import of a "Mechanical" System.—It has been a fond assumption of the kinematist that his all-embracing system of *motion* as the origin and essence of phenomena, is pre-eminently the "mechanical" theory of nature as contrasted with a "mystical" or "transcendental" theory. It may be well therefore to consider what is really signified by the term "mechanical."

Underlying every possible conception of the simplest element of a "machine" are two essential postulates:—first, the necessity of a frame-work invested with the inherent qualities giving it structural consistence and endurance,—and secondly, the necessity of a store of potential energy by which it may be actuated and made operative: since it is an elementary truism that no machine can *originate* energy.

The geometrician who ambitious of placing his science on a more rational basis should announce a new system rejecting all assumptions and establishing its theorems by no propositions which had not first been mathematically demonstrated, might possibly receive the applause of the inexpert, but would not be likely to meet with approbation or encouragement from the great jury of his brother geometers. The physicist who proclaims that he undertakes to build up a system of mechanical laws on a foundation exclusively mechanical, acts in no sense and in no degree less irrationally. Probably his first requirement will be—"given a rigid body." But

act of our minds." ISAAC NEWTON. (*Principia*. 1687: book III,—concluding "scholium.")

"In fact the causes of all phenomena are at last occult. There has however obtained a not unnatural presumption against such causes; and this presumption though often salutary has sometimes operated most disadvantageously to science." SIR WILLIAM HAMILTON. (*Discussions on Philosophy and Literature*. 8vo. London, 1852: appendix I, p. 611.)

"The first causes of phenomena lie beyond the limited scope of our perceptive and reasoning faculties. - - - Their intimate nature and prime origin are for us inscrutable mysteries." DR. A. W. HOFFMAN. (*Introduction to Modern Chemistry*. 1865: lec. IX, p. 138.)

"Ultimate scientific ideas then are all representative of realities that cannot be comprehended. - - - Alike in the external and the internal worlds, the man of science sees himself in the midst of perpetual changes—of which he can discover neither the beginning nor the end. - - - In all directions his investigations eventually bring him face to face with an insoluble enigma; and he ever more clearly perceives it to be an insoluble enigma." HERBERT SPENCER. (*First Principles*: 2d ed. 1869: part I, chap. III: sect. 21, pp. 66, 67.)

by no construction, by no combination, by no involution or evolution of any purely "mechanical" process can he possibly obtain, or explain, or even conceive his postulate—a rigid body. The attempt is indeed *more* hopeless than to demonstrate an axiom by mathematical deduction. That which is the necessary basis and starting-point of any intelligible mechanics, can scarcely be supposed to be the product or derivative of such mechanics. A truly mechanical theory cannot dispense with an extraneous foundation. Those who would exclude potential causes from the field of mechanical science, but betray the hopeless—helpless nakedness and imbecility of their hypothetic fictions. "Later philosophers" says Isaac Newton, "banish the consideration of such a cause out of natural philosophy, feigning hypotheses for explaining all things *mechanically*, and referring other causes to 'metaphysics;' whereas the main business of natural philosophy is to argue from phenomena without feigning hypotheses, and to deduce causes from effects, till we come to the very first cause,—*which certainly is not mechanical.*" *

Give to the ambitious kinematic artist his cloud of sand,—or if he prefer the outfit, let him be furnished with an indefinite quantity of a perfectly continuous frictionless and incompressible fluid—bound up if you please in a chain of "vortex rings,"—by no motions or composition of motions—continued through the æons of eternity—could he ever manufacture therefrom either a lever, or a rope. The kinematic gospel of a *mechanical* theory of primeval motion is therefore a sophism and illusion. It is founded on a misconception of the very *essence* of a true mechanics. And the system that would proudly aspire to an architecture of a kosmos from the elements of matter disrobed and denuded of every quality but motion, would achieve as its highest triumph and product—a universe of dust and ashes.

Without *inertia* there could be neither transmission of motion, nor even continuity of motion. Without inertia, kinematics itself would be but an empty name. And *with* inertia, kinematics would be a science of purely rectilinear movement; for by no artifice could any other be producible. No curvature of motion—no resilience of motion—is possible without the domination and constraint of occult forces. Without "dynamics" there could be no such thing as a science of "kinetics." Without the ceaseless presence and action of occult forces there could be no such thing as the

* *Optics*. Second edition, 1717: book III, query 28.

conservation of energy ; there could be no such thing as the production of energy.

Force—Real and Indispensable.—"Force" then is not a metaphorical abstraction : it is not a convenient asylum of ignorance. It is the most real,—the most fundamental,—the most inseparable of material attributes. It is the potency and faculty whereby all inorganic—no less than organic—forms are builded, and whereby alone their kaleidoscopic phenomena are revealed to our perceptions. And it is from the never resting antagonisms and reprisals of diverse forces that are made up the activity, the life, and the glory of the world in which we have our being ; to whose ever changing—ever becoming—ever nascent pageantry, the poetry of antiquity has given the name—*Natura*.

In spite of every effort made to realize a favorite dream, there is no "unity of force." To the dynamics of even a single molecule, the contestation and constraint of at least two opposite resisting agencies are indispensable : and in the various play of matter, other such agencies are no less clearly manifested. Nor is the certainty of multiplicity, in the slightest degree impaired by our admitted ignorance as to the final number of primeval forces. It may be that chemical affinity, and magnetism, are like heat, and electricity,* merely derivative forms of energy ; but at least this

* It is not a little remarkable that a tendency seems lately to have arisen to assign *electricity* to the station of a primitive force ; and several physicists have almost simultaneously maintained its indestructibility and inconvertibility.

Dr. O. J. LODGE, in a lecture delivered at the London Institution, December 16, 1880, says : " To the question What is electricity ?—We cannot assert that it is a form of matter, neither can we deny it ; on the other hand we certainly cannot assert that it is a form of energy, and I should be disposed to deny it. - - - It is as impossible to generate electricity in the sense I am trying to give the word, as it is to produce matter ! " (*Nature*. January 27, 1881 : vol. XXIII, p. 302.)

Mr. G. LIPPMAN, in a memoir presented to the Académie des Sciences of France, May 2, 1881, maintains that all electrical changes have an algebraic sum of zero : or in other words, that electricity can neither be created nor destroyed : the subject of the paper being " The Conservation of Electricity." (*Comptes Rendus*. 1881 : vol. XCII, p. 1049.—Also, *L. E. D. Phil. Mag.* June, 1881 : vol. XI, p. 474.)

Prof. SYLVANUS P. THOMPSON, "in Elementary Lessons in Electricity," (preface,) also maintains as an important hypothesis in the treat-

has not as yet been satisfactorily made out. The craving of the intellect for unity must therefore pursue its quest beyond and above the material empire of the physical forces.

The Conception of Natural "Law."—The habitudes of forces form the ultimate goal and boundary of scientific thought: and as the ascertainment and assignment of these habitudes (which we formulate as "laws" of matter) form the *object* of all science, so are their unerring certainty and uniformity of action at once the necessary *postulates* and the sole *condition* of all science. But the formulated "law" is but our mental concept of a habitude and a constancy whose method forever eludes our widest grasp, while forever challenging our most daring speculation. What is a law of nature? What is there behind it—to ordain or to enforce it. Do forces conform to the canons of an implicit prescription? Or is the so-called "law" but the summary and explication of autogenous deportment? Whichever be our assumption, the marvel and the incomprehensibility alike remain.

Sir John Herschel, in a playful colloquy "On Atoms," referring to their prompt obedience to the laws of their being, pithily asks: "Do they know them? Can they remember them? How else can they *obey* them?—conform to a fixed rule! Then they must be able to apply the rule as the case arises. - - - Their movements, their interchanges, their 'hates and loves,' their 'attractions and repulsions,' their 'correlations,' are all determined on the very instant. There is no hesitation, no blundering, no trial and error. A problem of dynamics which would drive Lagrange mad is solved *instantly*. A differential equation which algebraically written out would belt the earth, is integrated in an eye-twinkle."*

When we ask ourselves what these inflexible and unfailing laws of

ment of the subject, "the conservation of electricity;" holding "that electricity, whatever it may prove to be, is not matter and is not energy," and "that it can neither be created nor destroyed." (*Nature*. May 26, 1881: vol. xxiv, p. 78.—*Elementary Lessons*, [etc.] 12 mo. London, 1881.)

The electric and caloric fluids furnish a very striking and suggestive parallelism; and the common rotatory glass cylinder would have furnished Rumford with as pertinent a theme for his argument as his gun-boring lathe.

* *Fortnightly Review*. May 15, 1865: pp. 83, 84. Also, *Familiar Lectures on Scientific Subjects*. London, 1866: pp. 456, 458.

force really mean?—Why they are thus and not otherwise?—Why they are so diverse and irreducible, and each so perfectly autocratic?—Why for example independent molecules bound in the cohesion and adhesion of the “liquid” or the “solid” condition, should exhibit an attraction for each other a thousand-fold stronger than their mutual gravitation?—Why two atoms within a molecule should cling together with a tenacity only *increasing* with their enforced centrifugal separation, while perfectly similar atoms not thus united attract each other with a strength *decreasing* with the second power of their distance?—Why the chemical affinity of dissimilar molecules shall attach them with a force incomparably greater than even that of their physical cohesion?—so that a drop of water may be shattered and lifted by the sun-beam, precipitated in snow, ground beneath a glacier, re-melted and dashed to foam in tumbling cataracts, may be combined in the solid substance of a hydrated crystal or in the complex constitution of an organic being, may be tortured in the chemist’s retort or forced in hissing fury through the steam-engine, may pass through protean changes more varied than fable ever fancied, and yet in all these marvellous pilgrimages shall never loosen its structure as a compounded molecule of hydrogen and oxygen:—Why these same elements—so firmly enchained that the oxygen will quit its grasp only under the decomposing enticement of a more powerful affinity, or under the dissociative violence of a molecular velocity and clash representing the temperature of highest incandescence,—are yet so averse to separate condensation that only the combination of extremest cold and pressure attainable by human artifice has succeeded in bringing the molecules of either to a momentary liquid or solid cohesion?—we find such questionings though irresistibly suggested, as irreversibly removed outside the pale of oracle or answer. There is no mystery in the world of mind, that is not fully paralleled by mysteries as bewildering in the world of matter.

Hemmed in by the impassable limitations of a restricted experience and of a no less restricted faculty of reason, we find the finite radius of our science touching in every direction the shadowy universe of nescience; and where most we seem to know, there most we encounter the cloud-land of the unknowable. In our highest reach and proudest triumph of analytic achievement,—in that symbolical reasoning upon quantitative relation which we call *par excellence* the “mathematical,”—we find that our symbols over-step

their appointed purpose, and our equations traversing the mystic region of "imaginary" expressions, transcend alike our interpretation and our comprehension.

Final Unity of Causation.—As every suggestion of an assignable limit to space or time directly impels us to "overleap all bounds," so the very definiteness of the *physical* leads us to spring in imagination beyond its frontiers, and to seek refuge in the transcendental;—not the *supernatural* as replacing or suspending the natural, but as supplementing and completing it—the ultra-natural,—in its best and highest sense the *metaphysical*. Incapable though we be of realizing in thought anything but the finite and the relative, we none the less find ourselves alike incapable of confining our thought to these; and the necessity which inexorably forbids our conception of the infinite and the absolute, no less imperiously compels our unhesitating acceptance of the unknown infinite and absolute as the unavoidable counterparts of the known finite and relative.*

Our visible material universe—to all appearance limited in extent—an islet in the boundless void,—is no less limited in duration,—at least as to any of its aspects now displayed. Nor have the falling leaf or the ageing man, the disappearance of races or the past extinction of species of genera and of orders,—more clearly inscribed upon them, the universal law and lesson of ephemeral birth development and decay, than have the starry heavens themselves. *Under the present system of dynamic law*, it is certain that as radiating and cooling bodies,

"The stars shall fade away, the sun himself
Grow dim with age, and nature sink in years."

*Sir WILLIAM HAMILTON has well remarked (in his Essay on the "Philosophy of the Unconditioned"): "The *Infinite* and the *Absolute* (properly so called) are thus equally inconceivable to us. - - - We are thus taught the salutary lesson that the capacity of thought is not to be constituted into the measure of existence; and are warned from recognizing the domain of our knowledge as necessarily co-extensive with the horizon of our faith. And by a wonderful revelation we are thus in the very consciousness of our inability to conceive aught above the relative and finite, inspired with a belief in the existence of something unconditional beyond the sphere of all comprehensible reality." (*Discussions on Philosophy and Literature*. 8vo. London, 1852: part I, pp. 18 and 15.) This Essay—a Review of Victor Cousin's *Cours de Philosophie*,—was originally published in the *Edinburgh Review*, October, 1829: vol. I, pp. 194–221.

Nor is there known to science any natural process whereby this cosmic doom may be either averted, or repaired by ulterior reversal.* And when turning backward through precessive geneses of worlds and suns and systems, and recalling in imagination the heat continuously expended and dissipated during millions of millions of years, until all matter is volatilized and re-expanded in the uniform tenuity and diffusion of the primitive nebular chaos, we endeavor to extend our retrograde inspection for another billion of years,—lost in the dizzying retrospect, we find that we have neither scale, nor mechanical principle, nor hydrodynamical theory, whereby to gage or guess the antecedents of this nebular chaos.

And here again—behind the mystery and inconceivability of atomic forces, lies the still greater mystery and inconceivability of primæval nature. And yet majestic as the wondrous march of cosmic evolution—(by purely human standards), it has probably consumed no greater number of our fleeting years, than the revolutions executed by the slowest atoms in a single second of time! Or by whatever number this be multiplied, how brief an interval has it fulfilled in the great infinitude of panoramic time,—in the far-stretching ages of a past eternity.

While an intellectual necessity demands the continuity of causation and of sequence, and holds any cessation of these as positively unthinkable, we thus observe that on every side we are confronted

*Of various suggestions (made from a teleological stand-point) for reversing the great law of "dissipation," and supplying to declining systems an *elixir vitæ* for their perpetual regeneration, perhaps the two most notable are those of Rankine and of Siemens.

WILLIAM J. M. RANKINE, in a paper "On the Re-concentration of the Mechanical Energy of the Universe," read before the British Association at its Belfast meeting, in September, 1852,—assuming a boundary to the æthærial medium, argues that the radiations dissipated outward, would at the limiting surface be all reflected inward to foci, at which exhausted suns would be re-kindled into incandescence, or "vaporized and resolved into their elements." (*Report Brit. Assoc.* 1852: part II,—abstracts, p. 12.—Or more fully in *L. E. D. Phil. Mag.* November, 1852: vol. IV, p. 358.)

CHARLES WILLIAM SIEMENS, in a paper "On the Conservation of Solar Energy," read before the Royal Society, March 2, 1882, assuming gaseous products of combustion to be thrown off in a dissociated form from the equatorial regions of the revolving sun, (as from a centrifugal fan,) argues that they would be constantly indrawn at the polar regions, to be reburned and again given off,—in a perpetual circulation. (*Nature.* March 9, 1882: vol. XXV. pp. 440-444.)

and beset by barriers through which no loop-hole of escape appears. The mind thus baffled and bewildered in its backward inquest through illimitable series, in which to its dismay is found at no great distance—whether in atom, or in universe,—the chasm of a strange and incomprehensible discontinuity, the inevitable transition to an entirely different order of links from those made thinkable by experience, seems driven in the last resort to the unifying induction of a single, first, eternal, and all-powerful Cause—from which all other causes are dependent and derived.

This ultimate and highest induction of scientific thought—the Inscrutable made Absolute—is restful and satisfying. This ultimate and highest induction—as highest and ultimate, cannot be manipulated as a “working hypothesis.” This ultimate and highest induction—as such—cannot be subjected to the subsequent verification of mathematical deduction. This ultimate and highest induction detracts nothing from the certainty of orderly sequence so irresistibly impressed upon us by every deepening channel of research, but gives us rational ground and guarantee of such unfailing regularity. This ultimate and highest induction accepting to the uttermost the mechanical interpretation of nature’s administration,—whose ceaseless evolution seems ever opening up new vistas of an automatic teleology,—gives significance to our imperfect conception of a regulated system, (so necessarily involved in the very existence and operation of a “machine,”) and accounts consistently for the unfaltering obedience and instantaneous response of all the countless atoms of the universe to the reign of “law,” by positing behind such law—an Infinite LAW-GIVER.

In Richard Hooker’s never trite though memorable words: “Of *Law* there can be no less acknowledged than that her seat is the bosom of God, her voice the harmony of the world: all things in heaven and earth do her homage,—the very least as feeling her care, and the greatest as not exempted from her power.”

226TH MEETING.

DECEMBER 16, 1882.

TWELFTH ANNUAL MEETING.

The President in the Chair.

About fifty members were present during the evening.

The President announced the usual order of exercises.

The minutes of the last annual meeting were read and approved.

The Secretary, Mr. GILL, read the list of members who had been elected since the last annual meeting.

The Treasurer read his report upon the finances and property of the Society. (See page 180.)

The Chairman appointed as Auditing Committee, Messrs. Thomas Antisell, Benjamin Alvord, and Otis T. Mason.

The Treasurer read the roll of names of members who were entitled to vote at the election of officers.

The Society then proceeded to ballot for the election of officers, with the following result: (See next page.)

The rough minutes of the meeting were read and approved; and the meeting then adjourned.

OFFICERS

OF THE

PHILOSOPHICAL SOCIETY OF WASHINGTON.

 ELECTED DECEMBER 16, 1882.

President ----- J. W. POWELL.*Vice-Presidents* ----- J. C. WELLING, J. E. HILGARD,

C. H. CRANE, J. S. BILLINGS.

Treasurer ----- CLEVELAND ABBE.*Secretaries* ----- G. K. GILBERT, HENRY FARQUHAR.

MEMBERS AT LARGE OF THE GENERAL COMMITTEE.

W. H. DALL,

C. E. DUTTON,

J. R. EASTMAN,

E. B. ELLIOTT,

R. FLETCHER,

WM. HARKNESS,

D. L. HUNTINGTON,

GARRICK MALLERY,

C. A. SCHOTT.

 STANDING COMMITTEES.
*On Communications :*J. S. BILLINGS, *Chairman*.

G. K. GILBERT,

HENRY FARQUHAR.

*On Publications :*G. K. GILBERT, *Chairman*.

HENRY FARQUHAR,

CLEVELAND ABBE,

S. F. BAIRD.*

*As Secretary of the Smithsonian Institution.

ANNUAL REPORT OF THE TREASURER.

WASHINGTON, D. C., December 17, 1881.

To the Philosophical Society of Washington :

Owing to the change in the time of presentation of the Treasurer's report, I have the honor to present herewith my annual statement as Treasurer for the years 1880 and 1881, showing a cash balance on December 16th, in the treasury, of three hundred and twenty dollars and sixteen cents, (\$320.16.)

The investments of the Society consist of—

One United States bond, No. 4569 A, (registered,) of the funded loan 1891, for \$1,000, yielding $4\frac{1}{2}$ per cent. ;

One United States bond, No. 20031, (registered,) of the funded loan of 1907, for \$500, yielding 4 per cent.

The further assets of the Society consist of unpaid dues amounting to about three hundred and thirty dollars, (\$330.)

The active membership of the Society is to-day about one hundred and fifty-five, (155.)

The stock on hand of the publications of the Society is about as follows, by actual count :

	No. of copies.	Price to members.
Vol. I of the Bulletin-----	93	\$2 00
II "-----	92	3 00
III "-----	182	1 00
IV "-----	190	1 00
Taylor's Memoir of Prof. Henry—		
1st edition-----	64	50
2d "-----	30	1 00
Welling's Memoir of Prof. Henry-----	4	50

The Library has lately received, by way of exchange, about fifty volumes, but these have not yet been catalogued and arranged.

Special copies of each communication that appears in the Bulletin of the Society are promptly printed for distribution by the author; the annual volumes of the Bulletin are sent usually to about 125 domestic and foreign recipients, selected with special view to the general dissemination of information as to the activity of the Society.

The distribution of stitched annual volumes, instead of individual signatures, gives general satisfaction, and is much more economical

in time and labor. Much attention is given to collecting the scattered signatures of the first volume, and thus the stock in hand of the complete volume is being slowly replenished.

Volumes I, II, and III of the Bulletin have been stereotyped and printed (with some corrections) at the expense of the Smithsonian Institution as Volume XX of the Miscellaneous Collections. It is certainly a matter of congratulation that the Society has thus assured to it the economical, permanent, and most extensive publication of its proceedings; and the general effect of this arrangement is to offer stronger inducements to our members to publish through this medium.

The expense to the Society of the publication of the first three volumes of the Bulletin was easily borne by reason of the slow accumulation of the funds in the treasury; but the cost of publication of Volume IV has been entirely defrayed out of the income of the past year, and has required very nearly the whole of our receipts, so that the balance in the treasury is now only \$320.16, as compared with two hundred and fourteen dollars and eighty-two cents, (\$214.82) at the beginning of 1881. The Treasurer has therefore felt himself under the necessity of distributing this volume only to members who are not in arrears.

The actual expense of the editions of 500 copies each of the respective volumes has been very nearly as follows:

Vol.	No. of signatures.	Cost per edition.	Cost per copy.
No. I -----	10	\$386	\$0 77
II -----	18	686	1 37
III -----	12	333	67
IV -----	12	391	78

It is therefore probable that the steady increase in the membership and work of the Society is likely soon to so increase the extent and cost of our Bulletin as to absorb our whole income.

In view of the fact that the free use of our present admirable quarters is a privilege granted by the Surgeon-General, liable at any time to be revoked, I think it important that there should always be a very considerable annual surplus to be added to the permanently-invested fund, the income of which will at some future day enable the Society to lease appropriate quarters in some central locality.

I have the honor to remain, very respectfully,

CLEVELAND ABBE, *Treasurer.*

Dr.

The Philosophical Society of Washington in account with Cleveland Abbe, Treasurer.

Cr.

EXPENDITURES.

ANNUAL DUES RECEIVED DURING 1880.

Date.	Voucher.	Check.	To whom paid.	Amount.	Date.	1877.	1878.	1879.	1880.	1881.	Total.
1880.					1880.						
Jan. 29	1	36	S. N. Griffin	\$8 00	Apr. 30			\$15 00	\$30 00		\$45 00
Jan. 23	2	37	E. M. Whitaker	14 25	July 24			25 00	325 00		350 00
Apr. 14	3	38	Judd & Detweiler	12 50	Aug. 25	\$5 00	\$5 00	10 00	20 00		40 00
June 29	4	39	Judd & Detweiler	43 49	Oct. 27			10 00	40 00		50 00
July 22	5	40	C. Abbe	10 30	Nov. 9				70 00	\$5 00	75 00
July 24	6	41	T. K. Collins	194 09	Dec. 22			10 00	20 00	15 00	45 00
July 31	7	43	M. Joyce	15 50	Dec. 31		\$5 00	5 00	5 00		20 00
July 28	8	42	Judd & Detweiler	50 00							
Aug. 4	9	44	Judd & Detweiler	91 33							
Aug. 4	9	45	C. Abbe	20 00							
Aug. 13	10	46	T. K. Collins	4 00							
Aug. 31	11	47	Judd & Detweiler	13 56							
Dec. 6	12	48	T. K. Collins	14 20							
				</							

EXPENDITURES.

ANNUAL DUES RECEIVED DURING 1881.

Date.	Voucher.	Check.	To whom paid.	Amount.	Date.	1878.	1879.	1880.	1881.	1882.	Total.
1881.											
March 3	1	50	Judd & Detweiler	\$29 31	Feb. 26		\$5 00	\$45 00	\$15 00		\$65 00
March 4	2	51	Judd & Detweiler	10 00	May 9			5 00	20 00		25 00
June 6	3	52	Judd & Detweiler	10 00	May 19				85 00		85 00
Oct. 10	4	53	Judd & Detweiler	250 00	May 28			5 00	25 00		30 00
Nov. 18	5	55	Judd & Detweiler	156 20	May 31			5 00	45 00		50 00
Nov. 4	6	54	C. E. Dutton	20 65	Sept. 30		5 00	25 00	105 00		135 00
Nov. 22	7	56	C. E. Dutton	20 00	Nov. 25				55 00		55 00
Dec. 14	8	57	C. Abbe	5 00	Dec. 1	\$5 00	10 00	15 00	55 00		85 00
Dec. 15			F. B. Mohun	3 50	Dec. 15				15 00	\$5 00	20 00
			To Balance on hand	504 66		By total dues received					\$550 00
				320 16		By interest on invested funds:					
						One \$1,000 U. S. bond, 4½ per cent---					\$45 00
						One \$500 U. S. bond, 4 per cent---					15 00
						Total from invested funds					60 00
						By Balance carried forward from 1880					610 00
						By total from all sources					214 82
				\$824 82							\$824 82

ANNUAL REPORT OF THE TREASURER.

WASHINGTON CITY, Dec. 16, 1882.

To the Philosophical Society of Washington :

I have the honor to present herewith my annual statement as Treasurer, covering the year ending with December 15, 1882, and showing a cash balance deposited with Riggs & Co. of \$521.07. This balance is much larger than would have been the case had it not been decided to delay the publication of Volume V of the Bulletin.

The investment of the funds of the Society remains as in my last report, viz. :

One U. S. registered bond, \$1,000, at $4\frac{1}{2}$ per cent.

One U. S. registered bond, \$500, at 4 per cent.

The further assets of the Society consist of unpaid annual dues to the amount of \$300 for 1882, and of about \$200 for 1881 and earlier years.

The number of active members is now about 150 ; the corresponding annual income, about 800 dollars.

The stock in hand of publications remains as about as reported by me a year ago.

An accession catalogue of the library has been recently compiled. The number of volumes at present on hand is 68 ; these have been presented by way of exchange ; and we are especially indebted to the Royal Societies of Edinburgh, of Munich, and of New South Wales, and the Literary and Philosophical Society of Manchester for long series of volumes.

Very respectfully,

(Signed)

CLEVELAND ABBE,

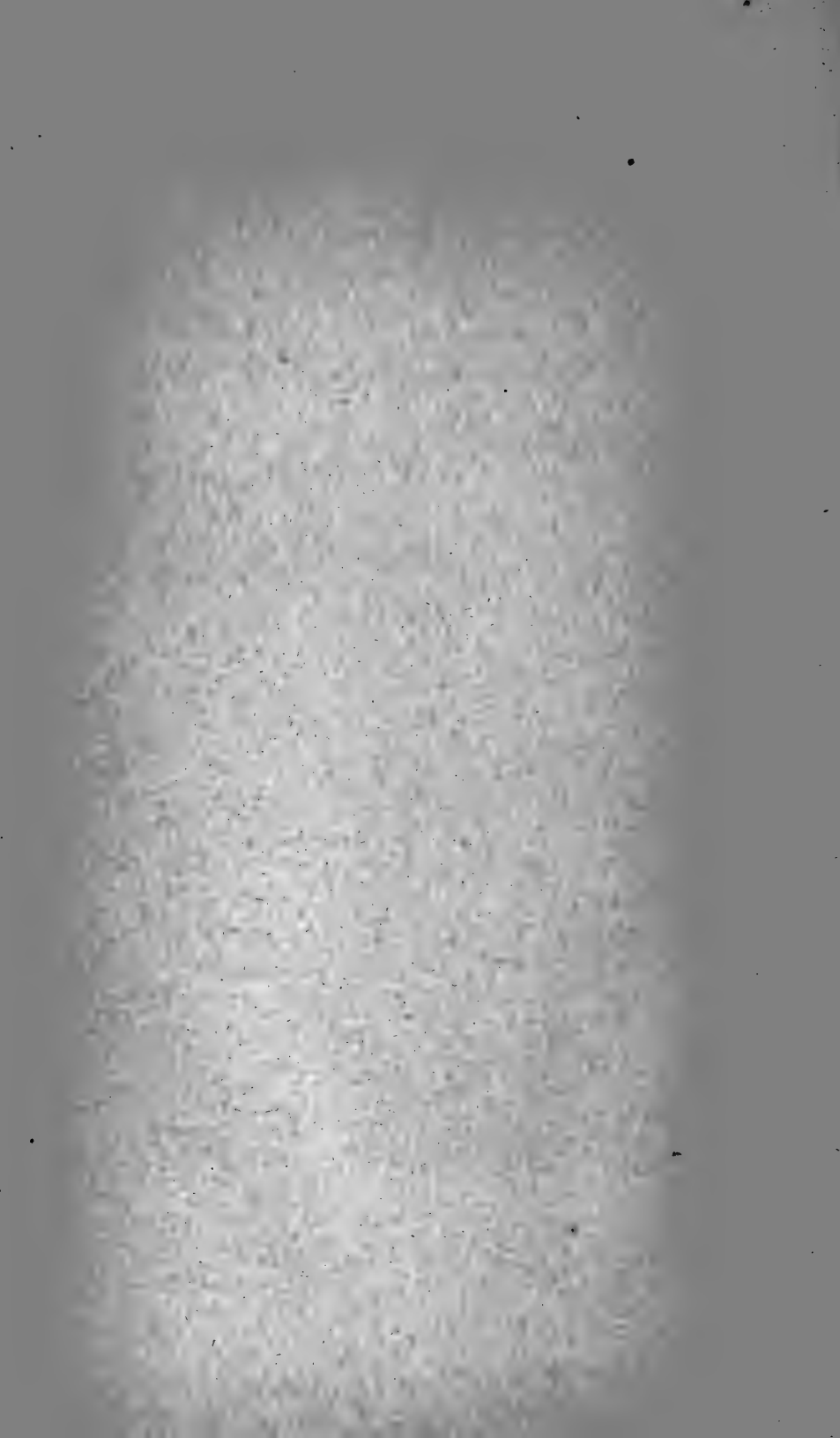
Treasurer.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

EXPENDITURES.					RECEIPTS.		
Date.	Vou'r.	Check.	To whom paid.	Amount.	From what source.	Amount.	Total.
1881.							
Dec. —	1	59	Judd & Detweiler	\$5 40	Credit by receipts as follows:		\$320 16
1882.					Balance carried over from December, 1881		
Jan. 30	2	60	S. J. Waldo	3 35	Annual dues received:		
Jan. 18	3	61	Marcus Baker	3 50	and deposited December 19, 1881	\$75 00	
Feb. 8	4	62	S. F. Bartlett	4 50	and deposited June 30, 1882	190 00	
March 2	5	63	Marcus Baker	3 00	and deposited July 31, 1882	175 00	
Feb. 28	6	64	Judd & Detweiler	21 30	and deposited December 2, 1882	75 00	
June 1	7	65	Marcus Baker	6 00			
May 31	8	66	Judd & Detweiler	22 95		\$515 00	
June 15	9	67	C. Abbe, Treasurer	7 25	Interest on invested funds, viz.:		
June 30	10	68	Judd & Detweiler	51 53	One \$1,000 U. S. bond, at 4½ per cent	45 00	
June 30	11	69	Marcus Baker	2 00	One \$500 U. S. bond, at 4 per cent	20 00	
July 14	12	70	Marcus Baker	2 00			
Oct. 4	13	71	Judd & Detweiler	2 50	Total receipts		580 00
Oct. 11	14	72	Judd & Detweiler	161 81			
Oct. 14	15	73	B. F. Brown	2 00			
			Total	\$379 09	Total from all sources		\$900 16
			Bal. on dep't with Riggs & Co.	521 07			
			Total	900 16			

We have examined this account and find the same correct and properly vouched. December 18, 1882.

Auditors: { THOMAS ANTISELL.
BENJ. ALVORD.
O. T. MASON.



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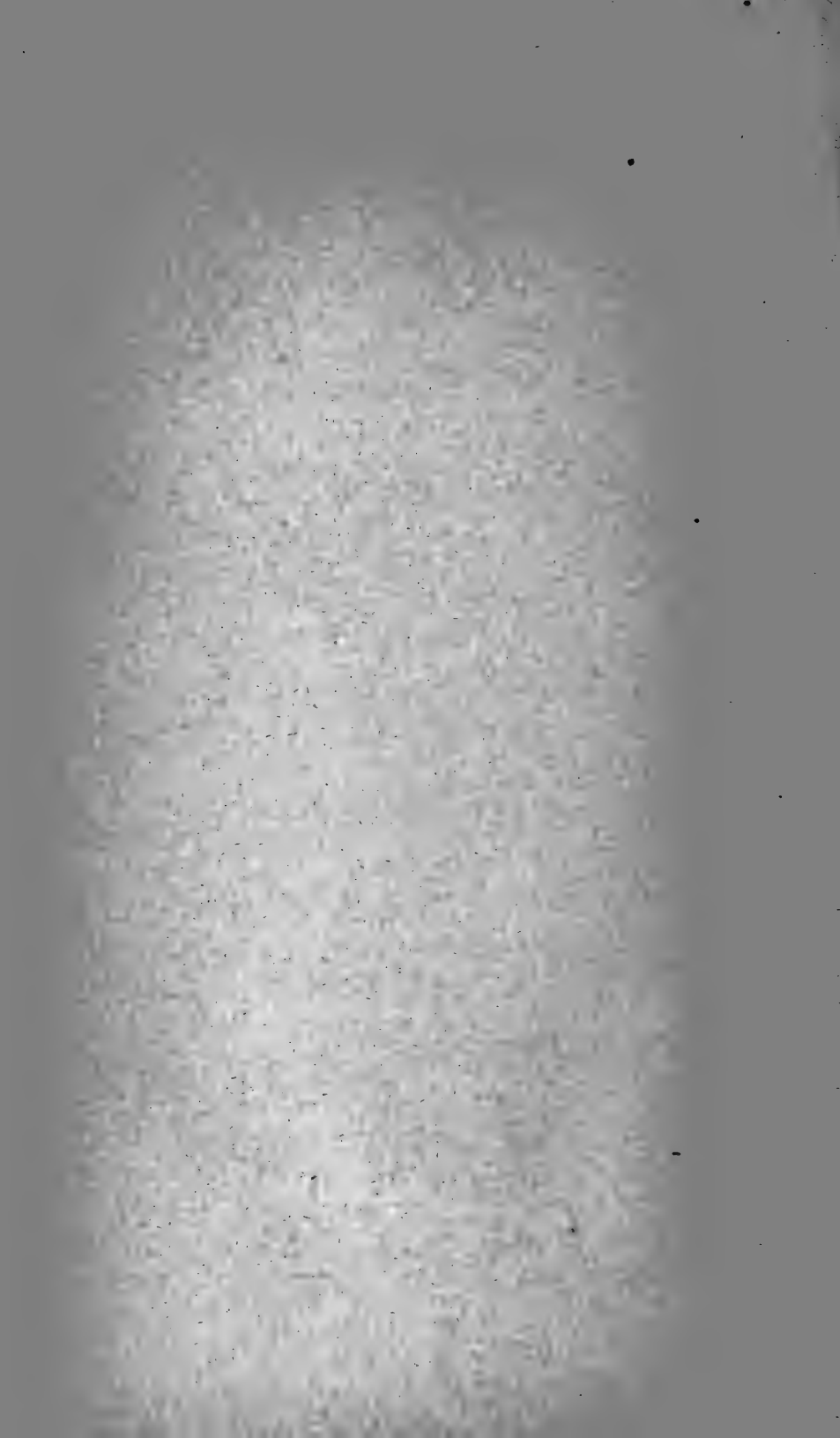
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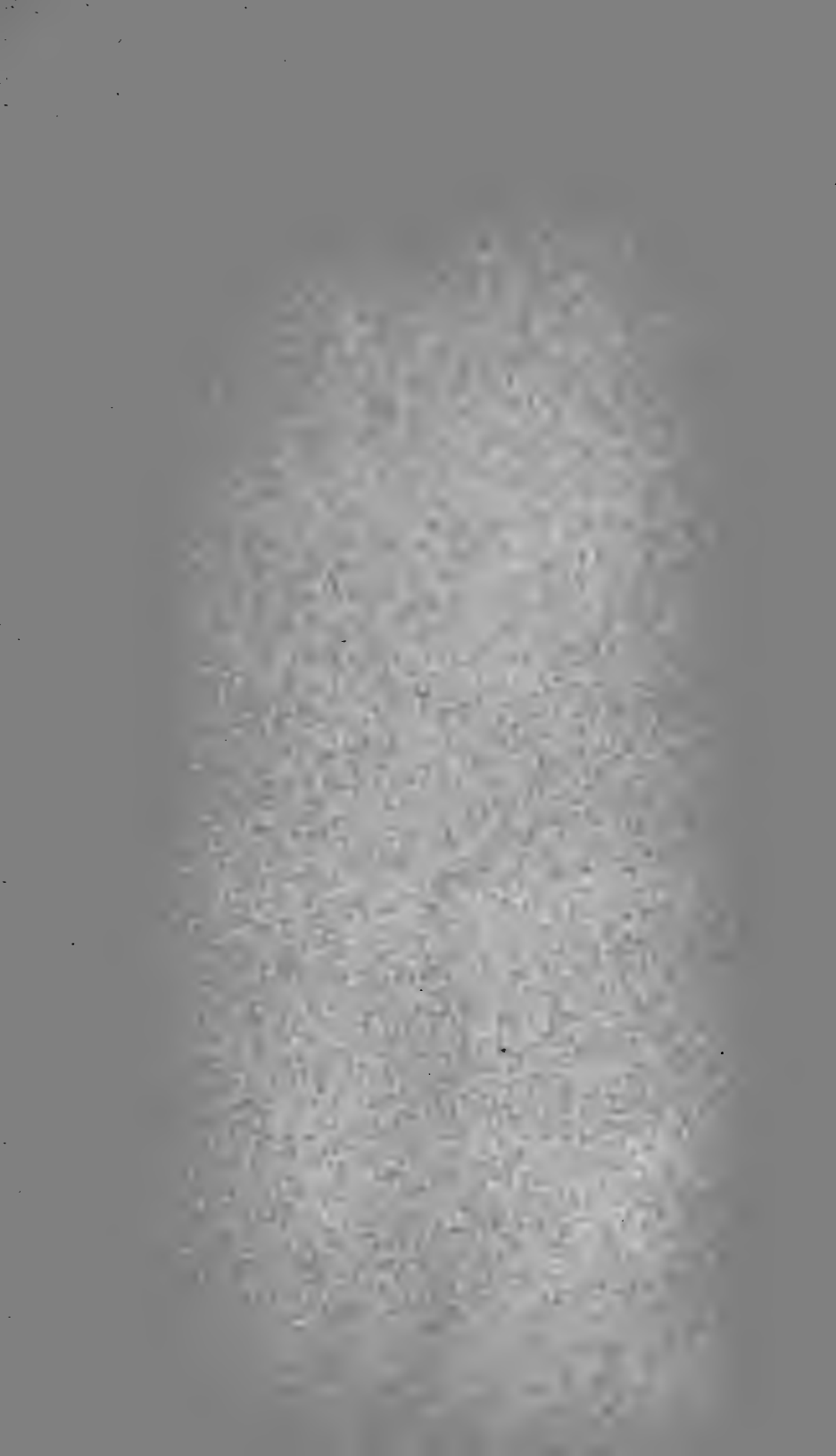
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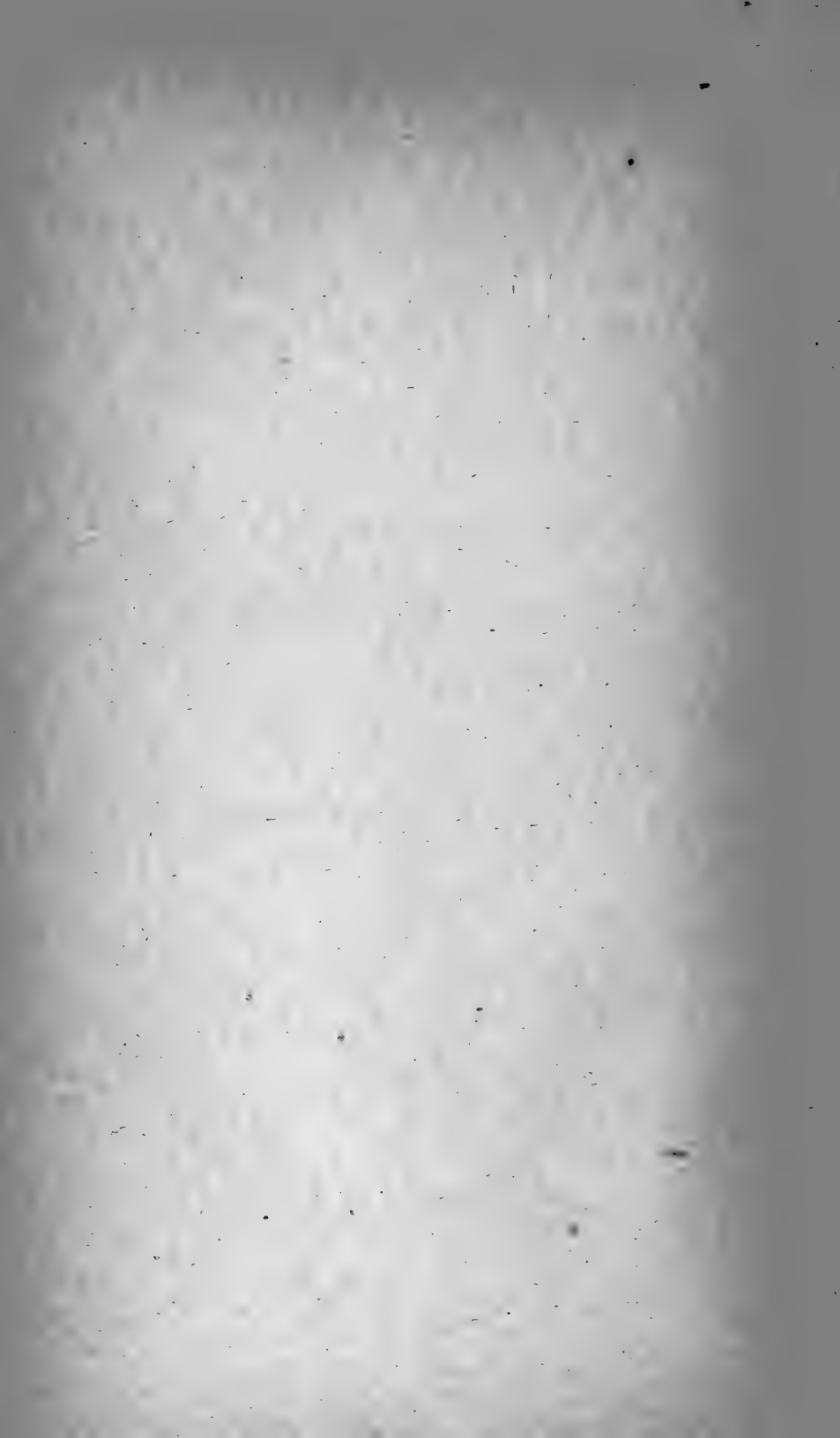
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PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON.

WITH THE ADDRESSES READ ON THE OCCASION OF THE
DARWIN MEMORIAL MEETING,
MAY 12, 1882.

PUBLISHED WITH THE CO-OPERATION OF THE SMITHSONIAN INSTITUTION.

VOLUME I.

NOVEMBER 19, 1880, TO MAY 26, 1882.

WASHINGTON:
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1882.

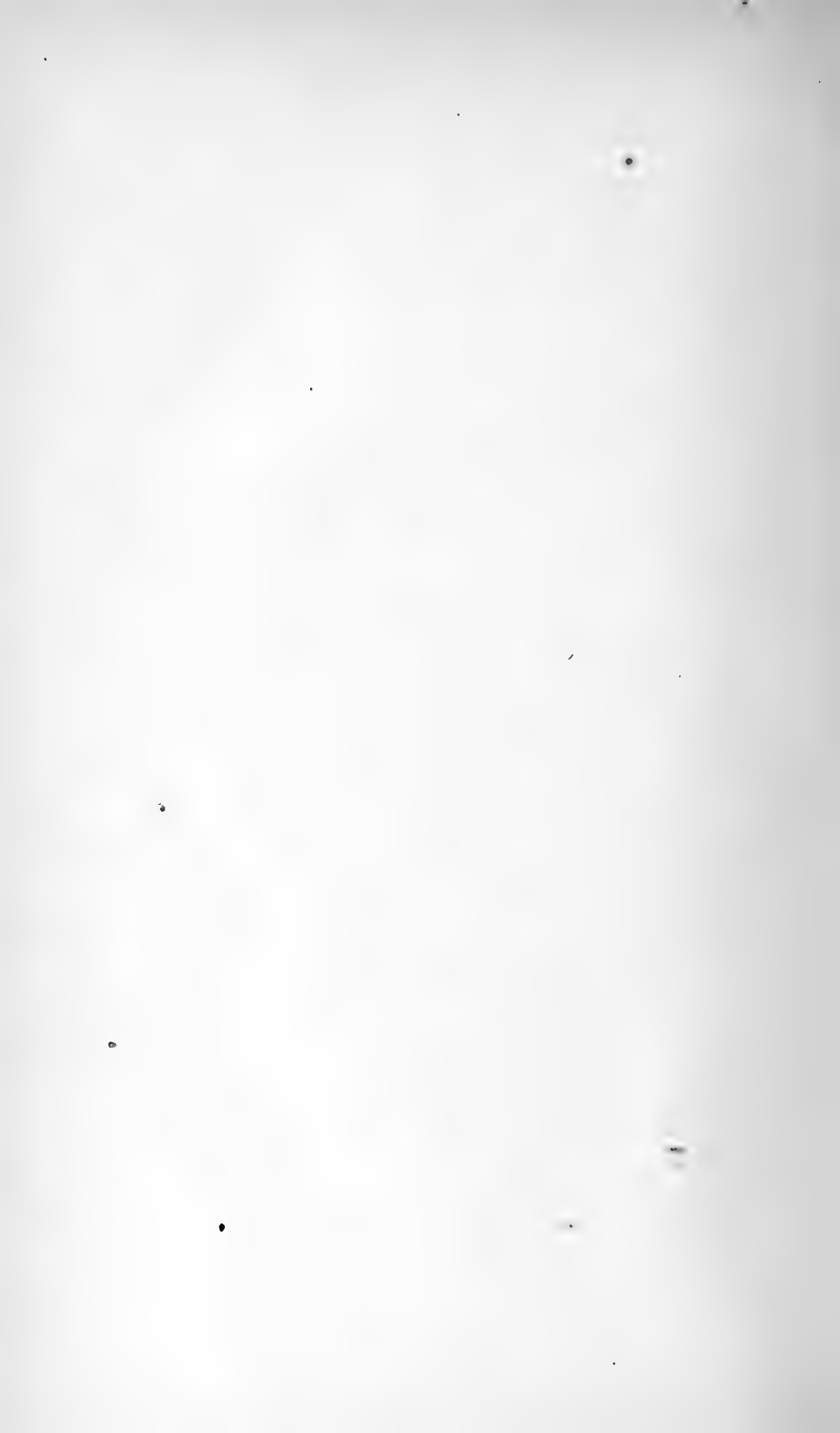


PUBLICATION COMMITTEE.

G. BROWN GOODE.

RICHARD RATHBUN.

LESTER F. WARD.



INTRODUCTORY NOTE.

THIS volume of Proceedings is published in obedience to the vote of the Society, passed May 26, 1882. The BIOLOGICAL SOCIETY OF WASHINGTON was organized December 3, 1880, and at the time of its summer adjournment, in 1882, carries upon its roll the names of one hundred and thirty-nine active members, one honorary member, and twenty corresponding members. It has held thirty-one regular meetings, three special meetings, and one field meeting. At its regular meetings fifty-four communications have been presented, nearly all of which, except informal verbal communications, have already been published, as is indicated in the bibliographical foot notes. It has inaugurated and, in conjunction with the Anthropological Society, carried on a course of eight popular scientific lectures, four of which were delivered in its special behalf, and all of which were delivered by its members.

The meetings of the Society have always been held in rooms provided by the courtesy of the Secretary of the Smithsonian Institution; the first fifteen in the Regents' Room of the Smithsonian Institution; the sixteenth to the twenty-fourth in the Archive Room of the National Museum; the subsequent meetings in the Lecture Room of the Museum.

In preparing the proceedings of the Society for publication, the Secretaries have omitted the record of the election of members from the minutes of the several meetings, the information there contained being presented in a much more convenient form in the "List of Members."



LIST
OF THE
COUNCIL AND OFFICERS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON.

1882.

COUNCIL.

THEODORE GILL, *President*.

TARLETON H. BEAN.	RICHARD RATHBUN.
JOHN W. CHICKERING, JR.	ROBERT RIDGWAY.
G. BROWN GOODE.	CHARLES V. RILEY.
JEROME H. KIDDER.	HENRY ULKE.
OTIS T. MASON.	GEORGE VASEY.
D. WEBSTER PRENTISS.	LESTER F. WARD.

OFFICERS.

PRESIDENT.

THEODORE GILL.

VICE PRESIDENTS.

CHARLES V. RILEY.	LESTER F. WARD.
JOHN W. CHICKERING, JR.	HENRY ULKE.

SECRETARIES.

G. BROWN GOODE.	RICHARD RATHBUN.
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TREASURER.

ROBERT RIDGWAY.



LIST OF MEMBERS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

JULY 1, 1882.

HONORARY MEMBERS.

Date of Election.	
1881, Jan. 14.	BAIRD, SPENCER FULLERTON, M. D., LL. D., M. N. A. S. Secretary of the Smithsonian Institution and Director of the U. S. National Museum. U. S. Commissioner of Fish and Fisheries. <i>Smithsonian Institution, and 1445 Massachusetts Avenue N. W.</i>

CORRESPONDING MEMBERS.

1882, Mar. 31.	AGASSIZ, ALEXANDER, A. B., S. B., M. N. A. S. Curator of the Museum of Comparative Zoology, Cambridge. <i>Cambridge, Massachusetts.</i>
1881, April 8.	ALLEN, JOEL ASAPH, M. N. A. S. Assistant in Ornithology in the Museum of Comparative Zoology, Cambridge. <i>Cambridge, Massachusetts.</i>
1882, April 28.	BREWER, WILLIAM HENRY, Ph. D., M. N. A. S. Professor of Agriculture in the Sheffield Scientific School, Yale College, New Haven. <i>New Haven, Connecticut.</i>
1881, Feb. 25.	BREWSTER, WILLIAM, <i>Cambridge, Massachusetts.</i>
1881, Feb. 25.	BROOKS, WILLIAM KEITH, Ph. D. Associate Professor of Biology and Director of the Marine Laboratory of Johns Hopkins University, Baltimore. <i>Baltimore, Maryland.</i>
1882, Jan. 6.	COLLETT, ROBERT, Docent and Assistant in the Zoological Museum of the University of Christiania. <i>Christiania, Norway.</i>
1882, April 14.	DERBY, ORVILLE ADELBERT, M. S., Chief of the Geological Survey of Brazil. <i>Rio de Janeiro, Brazil.</i>
1882, Jan. 6.	FARLOW, WILLIAM GILSON, A. M., M. D., M. N. A. S. Professor of Cryptogamic Botany in Harvard University. <i>Cambridge, Massachusetts.</i>

Date of Election.	CORRESPONDING MEMBERS—Continued.
1881, Mar. 11.	GIGLIOLI, ENRICO HILLYER, Director of the Royal Zoological Museum of Vertebrates, and Professor of Vertebrate Zoology in the Royal Institute, Florence. <i>R. Istituto de Studi Superiori, Florence, Italy.</i>
1882, Jan. 6.	GRAY, ASA, M. D., LL. D., M. N. A. S. Fisher Professor of Natural History in Harvard University. <i>Botanic Garden, Cambridge, Massachusetts.</i>
1882, Mar. 31.	GRIMM, OSCAR VON, Ph. D., Professor of Natural History in the <i>Forest Academy</i> , St. Petersburg. <i>St. Petersburg, Russia.</i>
1882, Jan. 6.	HYATT, ALPHEUS, S. B., M. N. A. S. Professor of Zoology and Paleontology in the Massachusetts Institute of Technology. Custodian of the Boston Society of Natural History. <i>Cambridge, Massachusetts.</i>
1881, April 8.	LAWRENCE, GEORGE N., 45 East 21st St., New York City.
1882, Mar. 31.	MORSE, EDWARD S., M. N. A. S. Director of the Peabody Academy of Science, Salem. <i>Salem, Massachusetts.</i>
1882, Mar. 31.	PACKARD, ALPHEUS SPRING, JR., M. D., M. N. A. S. Professor of Zoology and Geology in Brown University, Providence. <i>Providence, Rhode Island.</i>
1882, Mar. 3.	SMITH, SIDNEY IRVING, Ph. B. Professor of Comparative Anatomy in Yale College, New Haven. <i>New Haven, Connecticut.</i>
1881, Feb. 25.	VELIE, JOHN W., M. D. Secretary and Curator of the Chicago Academy of Sciences. 263 Wabash Avenue, Chicago, Illinois.
1882, Mar. 31.	VERRILL, ADDISON EMORY, A. M., S. B., M. N. A. S. Professor of Zoology and Curator of the Zoological Collections in Yale College, New Haven. <i>New Haven, Connecticut.</i>
1882, April 28.	WATSON, SERENO, Ph. D., M. N. A. S. Curator of the Herbarium of Harvard University. <i>Botanic Garden, Cambridge, Massachusetts.</i>
1882, Mar. 3.	WILSON, EDMUND BEECHER, Ph. D. Assistant in the Biological Laboratory of Johns Hopkins University, Baltimore. <i>Baltimore, Maryland.</i>

ACTIVE MEMBERS.*

Date of Election.	
Orig. Member.	ASHFORD, FRANCIS ASBURY, M. D. Dean of Faculty and Professor of Surgery in the Medical Department of the University of Georgetown. <i>1330 New York Avenue N. W.</i>
1881, Jan. 14.	BAKER, FRANK, M. D. Assistant Demonstrator of Anatomy and Prosector to the chair of Anatomy in the Medical Department of Columbian University. <i>Office of Light House Board, and 326 C Street N. W.</i>
1882, Mar. 3.	BARKER, JOHN SHEPARD, <i>715 H Street N. W.</i>
1881, Nov. 11.	BARNARD, WILLIAM STEEBINS, S. B., Ph. D. Assistant in the Entomological Division, U. S. Department of Agriculture. <i>1303 Q Street N. W.</i>
Orig. Member.	BEAN, TARLETON HOFFMAN, M. D. Curator, Dep't of Fishes, U. S. National Museum. <i>National Museum, and 1404 S Street N. W.</i>
1881, Mar. 25.	BESSELS, EMIL, M. D., Ph. D. <i>1441 Massachusetts Avenue N. W.</i>
1881, Nov. 11.	BEYER, HENRY G., M. D. Passed Assistant Surgeon, U. S. Navy. <i>Naval Hospital.</i>
1882, Mar. 17.	BILLINGS, JOHN SHAW, A. M., M. D. Surgeon and Brevet Lieutenant Colonel, U. S. Army. Librarian of the Surgeon General's Office. <i>Surgeon General's Office, and 3027 N Street N. W.</i>
1881, Jan. 14.	BIRNEY, HERMAN HOFFMAN, <i>1901 Harewood Avenue, Le Droit Park.</i>
1882, Jan. 20.	BIRNEY, GEN. WILLIAM, <i>1901 Harewood Avenue, Le Droit Park.</i>
1882; Feb. 17.	BLISH, JOHN BELL, Midshipman U. S. Navy, on duty in the National Museum. <i>Smithsonian Institution.</i>
1881, Nov. 11.	BRANSFORD, JOHN FRANCIS, M. D. Passed Assistant Surgeon, U.S.N., on duty at the Smithsonian Institution. <i>Smithsonian Institution.</i>
Orig. Member.	BROWN, JAMES TEMPLEMAN, Aid, U. S. National Museum. <i>National Museum, and 1425 S Street N. W.</i>

* When not otherwise expressly stated, all addresses are in Washington. By the word "Founder" are designated those who signed the call for the meeting for organization, November 26, 1880; by "Orig. Member" those who attended this and the succeeding meeting.

Date of Election.

ACTIVE MEMBERS—Continued.

Orig. Member.	BROWN, STEPHEN CARVOSSO, Registrar, U. S. National Museum. <i>National Museum, and 928 B Street S. W.</i>
Orig. Member.	BURDICK, EDSON ALMERON, <i>Pension Office, and 406 Spruce Street N. W.</i>
1882, Mar. 17.	BURNETT, SWAN MOSES, M. D. Lecturer on Ophthalmology and Otology in the Medical Department of the University of Georgetown. <i>1215 I Street N. W.</i>
Orig. Member.	BUSEY, SAMUEL CLAGETT, M. D. Professor of the Theory and Practice of Medicine in the Medical Department of the University of Georgetown. <i>1525 I Street N. W.</i>
1881, June 3.	CANBY, WILLIAM JACKSON, <i>413 Tenth Street N. W.</i>
1881, June 3.	CARMAN, MYRON ALBERT, D.D.S., <i>1015 Fourteenth St. N. W.</i>
1882, Feb. 17.	CHASE, HENRY SANDERS, Midshipman, U. S. Navy, on duty in the National Museum. <i>Smithsonian Institution.</i>
Founder.	CHICKERING, REV. JOHN WHITE, Jr., A. M. Professor of Natural Science in the Columbia Institution for the Deaf and Dumb. <i>Kendall Green, N. E.</i>
1881, May 20.	CHICKERING, JOHN JAMESON, A. M. Teacher in the Public Schools. <i>Kendall Green, N. E.</i>
1882, Mar. 17.	CHRISTIE, ALEXANDER SMYTH, Astronomical Computer in the U. S. Coast and Geodetic Survey. <i>Coast Survey Office, and 207 New Jersey Avenue N. W.</i>
1881, Jan. 28.	CLARK, ALONZO HOWARD, Special Agent in the Fishery Division of the Tenth Census. <i>National Museum, and 933 G Street N. W.</i>
1881, Feb. 25.	COLLINS, JOSEPH WILLIAM, Special Agent in the Fishery Division of the Tenth Census. <i>National Museum; and Gloucester, Massachusetts.</i>
Orig. Member.	COMSTOCK, JOHN HENRY, S. B. Assistant Professor of Ethnology and Lecturer on the Zoology of Invertebrates in Cornell University, Ithaca. <i>Ithaca, New York.</i>
1881, Dec. 23.	CONANT, WOODBURY PAGE, Assistant Botanist, Department of Agriculture. <i>Agricultural Department.</i>
1881, Dec. 23.	COUES, ELLIOTT, M. D., Ph. D., M. N. A. S. Professor of Anatomy in the Medical Department of Columbian University. <i>Smithsonian Institution, and 1321 N Street N. W.</i>

Date of Election.

ACTIVE MEMBERS—Continued.

- 1881, Nov. 11. COX, WILLIAM VAN ZANT, A. B. *Fish Commission Office, and 1011 Twelfth Street N. W.*
- 1881, Feb. 25. DALE, FRANK C., M. D. Passed Assistant Surgeon, U. S. N., on U. S. Steamer "Palos" on China Station.
- 1881, Jan. 28. DALL, WILLIAM HEALEY, Assistant, U. S. Coast and Geodetic Survey. Honorary Curator, Dept. of Mollusks, U. S. National Museum. *Coast Survey Office, and 1119 Twelfth Street N. W.*
- 1882, Feb. 3. DAVIS, HARRY C., A. B. Adjunct Professor of Greek in Columbian University. *637 Maryland Avenue S. W.*
- 1881, Feb. 25. DEHAAS, WILLS, M. D. *Care of Bureau of Ethnology, Smithsonian Institution.*
- 1881, Nov. 11. DEWEY, FREDERICK PERKINS, Ph. B. Assistant, Dept. of Metallurgy, U. S. National Museum. *National Museum, and Whitney Avenue N. W.*
- 1881, Nov. 11. DODGE, CHARLES RICHARDS, Special Agent, Tenth Census, Division of Fruit and Orchard Statistics. *1336 Vermont Avenue N. W.*
- 1882, Jan. 20. DOSH, FRANK BOWMAN. *Johns Hopkins University, Baltimore.*
- 1881, Jan. 28. EARLL, ROBERT EDWARD, S. B. Special Agent in the Fishery Division of the Tenth Census. *National Museum, and 601, M Street N. W.*
- 1881, Feb. 25. ELLIOTT, HENRY WOOD. *Smithsonian Institution, and Cleveland, Okio.*
- 1881, Nov. 25. ELLZEY, MASON GRAHAM, A. M., M. D. Lecturer on Hygiene and Medical Jurisprudence in the Medical Department of the University of Georgetown. *1012 I Street N. W.*
- 1881, Jan. 28. FERGUSON, THOMAS B., Assistant Commissioner of Fisheries. *1435 Massachusetts Avenue N. W.*
- 1881, Mar. 25. FLETCHER, ROBERT, M. D., Acting Assistant Surgeon, U. S. Army. *Surgeon General's Office, and 1326 L Street N. W.*
- 1881, Feb. 11. FLINT, JAMES MILTON, M. D. Surgson, U. S. Navy. Honorary Curator, Section of Materia Medica, U. S. National Museum. *National Museum, and Riggs House.*
- 1881, Dec. 9. FOREMAN, EDWARD, M. D. Assistant, U. S. National Museum. *National Museum, and 200 Eleventh Street S. W.*

Date of Election.

ACTIVE MEMBERS—Continued.

- 1882, Feb. 17. GARRETT, LEROY MASON, Midshipman, U. S. Navy, on duty at the National Museum. *Smithsonian Institution.*
- 1881, Mar. 25. GANNETT, HENRY, S. B., A.Met.B. Geographer of the Tenth Census and of the U. S. Geological Survey. *Office of Geological Survey, and 1881 Harewood Ave., Le Droit Park.*
- Orig. Member. GEDNEY, CHARLES DEFOREST, *Coast Survey Office, and 115 F Street N. E.*
- 1881, Mar. 11. GIHON, ALBERT LEARY, A. M., M. D. Member of Naval Board of Inspection. Medical Director, U. S. Navy. *1736 I Street N. W.*
- 1882, April 28. GILBERT, GROVE KARL, Geologist, U. S. Geological Survey. In charge of the Division of the Great Basin. *Office of Geological Survey, and 1881 Harewood Ave., Le Droit Park.*
- Founder. GILL, THEODORE NICHOLAS, M. D., Ph. D., M. N. A. S. Lecturer on Natural History in Columbian University. *Cosmos Club, and 321 and 323 Four-and-a-half Street.*
- Founder. GOODE, GEORGE BROWN, A. M. Assistant Director of the U. S. National Museum. Chief of Division of Fisheries, U. S. Fish Commission, and Special Agent in charge of Fishery Division, Tenth Census. *Smithsonian Institution, and 1620 Massachusetts Avenue N. W.*
- Orig. Member. GORE, JAMES HOWARD, S. B. Adjunct Professor of Mathematics in Columbian University. Honorary Curator of the Food Collection, U. S. National Museum. *Columbian University, and 1305 Q Street N. W.*
- 1881, Nov. 11. GRIFFITH, SAMUEL HENDERSON, M. D. Passed Assistant Surgeon, U. S. Navy. *Bureau of Medicine, U. S. Navy.*
- Orig. Member. HASSLER, FERDINAND AUGUSTUS, M. D. *1234 Thirteenth Street N. W., and Tustin City, Los Angeles Co., California.*
- 1881, Feb. 25. HAWES, GEORGE WESSON, Ph. D. Curator, Dept. of Mineralogy, U. S. National Museum. Special Agent in charge of the Building Stone Division, Tenth Census. **Died at Colorado Springs, Colorado, June 23, 1882.**
- 1882, Feb. 3. HAWKES, WILLIAM HIMES, A. B., M. D. Acting Assistant Surgeon, U. S. Army. *U. S. Army Dispensary, and 1105 F Street N. W.*
- 1882, Feb. 17. HAYDEN, EDWARD EVERETT, Midshipman, U. S. Navy, on duty at the National Museum. *Smithsonian Institution.*

LIST OF MEMBERS.

15

Date of Election.

ACTIVE MEMBERS—Continued.

1882, Mar. 31.	HENSHAW, HENRY WETHERBEE, Special Agent in the Indian Division of the Tenth Census. <i>Bureau of Ethnology, Smithsonian Institution, and 903 M Street N. W.</i>
1881, Jan. 14.	HESSEL, RUDOLPH, Ph. D., Superintendent of Government Carp Ponds. <i>514 Tenth Street N. W.</i>
Orig. Member.	HOFFMAN, WALTER JAMES, M. D. <i>Bureau of Ethnology, Smithsonian Institution, and 222 E Street N. W.</i>
1882, April 14.	HORNADAY, WILLIAM TELL, Chief Taxidermist U. S. National Museum. <i>National Museum, and Harewood Avenue, Le Droit Park.</i>
1882, May 26.	HOUGH, FRANKLIN BENJAMIN, Ph. D. Chief of Division of Forestry, U. S. Department of Agriculture. <i>Agricultural Department.</i>
1882, April 27.	HOUGH, MYRON BEACH WARNER. <i>U. S. Treasurer's Office, and 312 Indiana Avenue N. W.</i>
Orig. Member.	HOWARD, LELAND O., S. B. Assistant in the Entomological Division, U. S. Department of Agriculture. <i>Agricultural Department, and 1407 Fifteenth Street N. W.</i>
1881, Feb. 25.	HOWLAND, EDWIN PERRY, M. D. <i>211 Four-and-a-half Street N. W.</i>
Founder.	INGERSOLL, ERNEST. <i>New York City.</i>
1882, Mar. 3.	JOHNSON, ARNOLD BURGESS, A. M., Chief Clerk, U. S. Light House Board. <i>Le Droit Park.</i>
1882, Jan. 20.	JOHNSON, BLANCHARD FREEMAN. <i>Le Droit Park.</i>
1882, Feb. 3.	JOHNSON, JOSEPH TABER, A. M., M. D. Professor of Obstetrics and Diseases of Women and Infants, in the Medical Department of the University of Georgetown. Gynecologist to Providence Hospital. <i>937 New York Avenue N. W.</i>
Orig. Member.	JOUY, PIERRE LOUIS, Assistant Naturalist of U. S. Steamer "Palos" on China Station.
Orig. Member.	KIDDER, JEROME HENRY, A. M., M. D. Surgeon, U. S. Navy. <i>Bureau of Medicine, U. S. Navy, and 1601 O Street N. W.</i>
Orig. Member.	KING, ALBERT FREEMAN AFRICANUS, M. D. Professor of Obstetrics and Diseases of Women and Children, in the Medical Department of Columbian University. <i>726 Thirteenth Street N. W.</i>

Date of Election.	ACTIVE MEMBERS—Continued.
1881, Nov. 25.	KOEBELE, ALBERT, Aid, U. S. National Museum. <i>1700 Thirteenth Street N. W.</i>
Orig. Member.	LEE, WILLIAM, M. D. Professor of Physiology in the Medical Department of Columbian University. <i>2111 Pennsylvania Avenue N. W.</i>
1882, Mar. 17.	LEECH, DANIEL, <i>Smithsonian Institution, and 1507 Vermont Avenue N. W.</i>
1882, Jan. 20.	LEHNERT, REV. E., Pastor, German Lutheran Church.
1881, Jan. 28.	MCDONALD, MARSHALL, Chief of Division of Propagation and Transportation, U. S. Fish Commission. Commissioner of Fisheries for the State of Virginia. Special Agent Fishery Division of Tenth Census. <i>Fish Commission Office, and 909 Twenty-third Street N. W.</i>
1881, May 20.	MCMURTRIE, WILLIAM, E. M., M. S., Ph. D. Examiner of Wool in the U. S. Department of Agriculture. <i>Agricultural Department, and 1728 I Street N. W.</i>
1881, Nov. 11.	MANN, BENJAMIN PICKMAN, A. M. Assistant in the Entomological Division, U. S. Department of Agriculture. <i>Agricultural Department, and 1203 Q Street N. W.</i>
1882, Feb. 17.	MARSH, CHARLES CARROLTON, Midshipman, U. S. Navy, on duty at National Museum. <i>Smithsonian Institution.</i>
1882, Jan. 20.	MARTIN, FRANK, Aid, U. S. National Museum. <i>National Museum, and 1335 G Street N. W.</i>
Orig. Member.	MARX, GEORGE, Zoological Draughtsman, U. S. Department of Agriculture. <i>Agricultural Department, and 1626 Fourteenth Street N. W.</i>
Orig. Member.	MASON, OTIS TUFTON, Ph. D. Principal of the Preparatory Department of Columbian University. <i>1305 Q St. N. W.</i>
1881, Jan. 28.	MERRILL, GEORGE PERKINS, M. S. Aid, U. S. National Museum. <i>National Museum, and 3033 N Street N. W.</i>
1881, June 3.	MILLER, BENJAMIN, Jr. <i>1516 Thirty-first Street N. W.</i>
1882, Feb. 17.	MINER, RANDOLPH HUNTINGTON, Midshipman, U. S. Navy, on duty at National Museum. <i>Smithsonian Institution.</i>
1881, Dec. 9.	NELSON, EDWARD W., U. S. Signal Service observer at St. Michael's, Alaska. <i>Smithsonian Institution.</i>
Orig. Member.	NORRIS, BASIL, M. D. Surgeon and Brevet Colonel, U. S. Army. <i>1829 G Street N. W.</i>

LIST OF MEMBERS.

17

Date of Election.

ACTIVE MEMBERS—Continued.

Founder.	PATTON, WILLIAM HAMPTON, A. B. <i>New York City.</i>
Orig. Member.	PERGANDE, THEODORE, Assistant in Entomological Division, U. S. Department of Agriculture. <i>321 D Street N. W.</i>
Orig. Member.	PORTER, JOHN HAMPDEN, M.D. <i>2720 M Street N. W.</i>
1881, Feb. 11.	POWELL, JOHN WESLEY, Ph. D., LL. D., M. N. A. S. Direc- tor, U. S. Geological Survey, and Director, Bureau of Eth- nology, Smithsonian Institution. <i>National Museum, and 910 M Street N. W.</i>
Orig. Member.	PRENTISS, DANIEL WEBSTER, A.M., M.D. Professor of Ma- teria Medica and Therapeutics, in the Medical Department Columbian University. Commissioner of Pharmacy, District of Columbia. <i>1224 Ninth Street N. W.</i>
Founder.	RATHBUN, RICHARD, Curator, Dep't of Marine Invertebrates, U. S. National Museum. <i>Smithsonian Institution, and 1622 Massachusetts Avenue N. W.</i>
1881, May 20.	RAU, CHARLES, Ph. D. Curator, Dept. of Antiquities, U. S. National Museum. <i>Smithsonian Institution.</i>
1881, Dec. 9.	REYBURN, ROBERT, A. M., M. D. Professor of Physiology and Hygiene, Medical Department, Howard University. <i>2129 F Street N. W.</i>
Founder.	RIDGWAY, ROBERT, Curator, Dep't of Birds, U. S. National Mu- seum. <i>Smithsonian Institution, and 218 Eleventh Street S. W.</i>
Founder.	RILEY, CHARLES VALENTINE, Ph. D. President, U. S. Ento- mological Commission. Entomologist U. S. Department of Agriculture. Honorary Curator, of Insects in the U. S. National Museum. <i>Agricultural Department, and 1700 Thirteenth Street N. W.</i>
1882, Mar. 17.	RICHEY, STEPHEN OLIN, M. D. <i>1426 New York Avenue.</i>
1882, April 28.	RUSSEL, ISRAEL COOK, Assistant Geologist U. S. Geological Survey. <i>Salt Lake City, Utah.</i>
1882, Mar. 31.	RYDER, JOHN ADAM, Embryologist, U. S. Fish Commission. <i>Smithsonian Institution, and Chambersburg, Pa.</i>
Orig. Member.	SCHÆFFER, EDWARD MARTIN, M. D. <i>St. Cloud Building, and 1114 Nineteenth Street N. W.</i>
1882, Jan. 20.	SCHÖNBORN, HENRY. <i>213 Seventh Street N. W.</i>
1881, Mar. 11.	SCHUERMANN, CARL WILHELM, U. S. National Museum <i>and 916 D Street S. W.</i>

Date of Election	ACTIVE MEMBERS—Continued.
Orig. Member.	SCHWARZ, EUGENE AMANDUS, Assistant in the Entomological Division, U. S. Department of Agriculture. <i>606 H Street N. W.</i>
1881, Jan. 14.	SCUDDER, CHARLES WILLIS, Clerk, U. S. Fish Commission. <i>127 F Street N. E.</i>
Orig. Member.	SCUDDER, NEWTON PRATT, A.M. Aid, U. S. Fish Commission. <i>127 F Street N. E.</i>
1882, May 26.	SEATON, CHARLES W., Superintendent of the Tenth Census. <i>Census Office, and 303 M Street N. W.</i>
Orig. Member.	SEAMAN, WILLIAM HENRY, A. M. Professor of Chemistry in the Medical Department of Howard University. <i>1424 Eleventh Street N. W.</i>
Orig. Member.	SHELDON, CHARLES STILES. <i>Census Office.</i>
1881, Nov. 11.	SHUFELDT, ROBERT WILSON, M.D. Assistant Surgeon and Captain U. S. Army. Hon. Curator, Section of Bird Skeletons U. S. National Museum. <i>National Museum, and 819 Seventeenth Street N. W.</i>
1882, Feb. 17.	SHUTE, DANIEL KERFOOT, A. B. Children's Hospital. <i>Columbian College Hill.</i>
1881, Nov. 11.	SMITH, WILLIAM ROBERT, Superintendent of U. S. Botanical Garden. <i>Botanical Garden.</i>
Orig. Member.	SMILEY, CHARLES WESLEY, A. M. Chief of Division of Records, U. S. Fish Commission. Special Agent, Fishery Division, Tenth Census. <i>Fish Commission Office, and 1207 Eleventh Street N. W.</i>
1881, Nov. 11.	STEJNEGER, LEONHARD, (of Bergen, Norway.) Aid U. S. National Museum. Absent in Siberia.
1881, Mar. 25.	STERNBERG, GEORGE MILLER, M.D. Surgeon, U. S. Army. Secretary of the National Board of Health. <i>Fort Point San José, San Francisco, Cal.</i>
1882, Mar. 17.	STEVENSON, JAMES, Executive Officer of the U. S. Geological Survey. <i>National Museum.</i>
1881, Feb. 25.	STIMPSON, WILLIAM GORDON. <i>National Museum, and 211 Twelfth Street S. W.</i>
1882, Feb. 17.	STREETS, THOMAS HALE, M. D. Passed Assistant Surgeon, U. S. Navy. <i>Bureau of Medicine, U. S. Navy.</i>

LIST OF MEMBERS.

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Date of Election.	ACTIVE MEMBERS—Continued.
1882, Mar. 17.	TAYLOR, FREDERICK WILLIAM, Chemist, U. S. National Museum. <i>National Museum, and 1120 Vermont Avenue N. W.</i>
Orig. Member.	TAYLOR, THOMAS, M. D. Microscopist, U. S. Department of Agriculture. <i>Agricultural Department, and 238 Massachusetts Avenue N. E.</i>
1881, Dec. 9.	THOMPSON, JOHN FORD, M. D. Professor of Surgery, Medical Department, Columbian University. <i>1000 Ninth Street N. W.</i>
1881, Jan. 28.	TODD, JAMES EDWARD, Ph. D. Professor of Natural History in Tabor College and Lecturer in Beloit College. <i>Tabor, Iowa.</i>
Orig. Member.	TONER, JOSEPH MEREDITH, M. D. <i>615 Louisiana Avenue N. W.</i>
Founder.	TRUE, FREDERICK WILLIAM, M. S. Librarian, and Curator Dep't of Mammals, U. S. National Museum. <i>National Museum, and 3033 N Street N. W.</i>
1881, Dec. 23	TURNER, LUCIEN M., Observer, U. S. Signal Service. <i>Ungava, Labrador.</i>
Orig. Member.	ULKE, HENRY, <i>1111 Pennsylvania Avenue N. W.</i>
1881, Mar. 25.	UPHAM, EDWIN PORTER, Aid, U. S. National Museum. <i>Smithsonian Institution, and 1317 Eleventh Street N. W.</i>
Founder.	VASEY, GEORGE, M. D. Botanist, U. S. Department of Agriculture. <i>Agricultural Department, and 1437 S Street N. W.</i>
Founder.	WARD, LESTER FRANK, A. M., LL. B. Paleo-botanist, U. S. Geological Survey. Honorary Curator, Dep't of Fossil Plants, U. S. National Museum. <i>National Museum, and 1464 Rhode Island Avenue N. W.</i>
Orig. Member.	WHITE, CHARLES ABIATHAR, A. M., M. D. Curator, Dep't of Fossil Invertebrates, U. S. National Museum. Palæontologist U. S. Geological Survey. <i>National Museum, and 409 Maple Avenue, Le Droit Park.</i>
1881, May 20.	WHITE, MAURICE PUTNAM, Teacher, Public Schools. <i>507 Sixth Street N. W.</i>
1881, Jan. 28.	WILLIAMS, ALFRED, <i>Department of State, and 134 C Street N. E.</i>

Date of Election.

ACTIVE MEMBERS—Continued.

Orig. Member.	WILSON, JOSEPH McMUNN. <i>U. S. Pension Office, and 1108 Maryland Avenue S. W.</i>
1881, Dec. 9.	WINSLOW, FRANCIS, Lieutenant, U. S. Navy, on duty with U. S. Fish Commission. <i>Brightwood, D. C.</i>
1881, Jan. 28.	WOLFLEY, WILLIAM IRVIN, A. M., M.D. <i>140 C Street N. E.</i>
1882, Feb. 17.	YARNALL, JOHN HEPBURN, M. D. <i>3028 P Street N. W.</i>
Orig. Member.	YARROW, HENRY CRÉCY, M. D. Acting Assistant Surgeon U. S. Army. Hon. Curator, Dept. of Reptiles U. S. National Museum. <i>Surgeon General's Office, and 814 Seventeenth Street N. W.</i>
1881, Feb. 25.	YEATES, WILLIAM SMITH, A. M. Aid, U. S. National Museum. <i>National Museum, 2522 L Street N. W.</i>
1882, Jan. 6.	ZUMBROCK, ANTON, M. D., Electrotyper and Photographer, U. S. Coast and Geodetic Survey. <i>Coast Survey Office, and 306 C Street N. W.</i>

THE BIOLOGICAL SOCIETY OF WASHINGTON

CONSTITUTION.

Adopted December 3, 1880.

ARTICLE I.

NAME.

The name of this Society shall be "THE BIOLOGICAL SOCIETY OF WASHINGTON."

ARTICLE II.

OBJECTS.

Its objects shall be to encourage the study of the Biological Sciences, and to hold meetings at which papers shall be read and discussed.

ARTICLE III.

MEMBERS.

The Society shall consist of active, corresponding and honorary members. Candidates for membership shall be proposed to the Council, in writing, by at least three members, and, upon recommendation of the majority of the Council present at its regular meeting, shall be balloted for at the earliest ensuing meeting. A majority vote of the members present when the ballot is taken shall be necessary to election.

ARTICLE IV.

OFFICERS.

The officers shall be a President, four Vice Presidents, two Secretaries, and a Treasurer. There shall be a Council, consisting of the officers of the Society and five members, to be elected by the Society. A quorum of the council shall consist of seven members.

Its duties shall be to act on nominations for membership, have the direction of the finances, audit the accounts of the Treasurer, and provide a programme for each meeting of the Society.

The officers shall be elected by ballot at each annual meeting, and shall serve one year, or until their successors are elected.

ARTICLE V.

PRESIDENT AND VICE PRESIDENTS.

The President, or, in his absence, one of the Vice Presidents, shall preside at meetings of the Society and Council. The presiding officer shall appoint all committees in the Council and in the Society, unless otherwise ordered. It shall be the duty of the retiring president to deliver an address at the second meeting in January.

ARTICLE VI.

SECRETARIES.

The Secretaries shall take and preserve correct minutes of the proceedings of the Society and Council and a record of the members, shall conduct its correspondence, give due notice of all meetings, and inspect and count all ballots.

ARTICLE VII.

TREASURER.

The Treasurer shall have charge of all money and other property of the Society, and shall make disbursements under the direction of the Council. He shall collect all fees and assessments, and notify members who may be in arrears.

ARTICLE VIII.

SECTIONS.

Sections for special work in any department of Biology may be formed upon the recommendation of the Council.

ARTICLE IX.

MEETINGS.

Stated meetings shall, unless otherwise ordered, be held on Friday of each alternate week, at eight o'clock P. M. The annual meeting

for the election of officers shall be the first meeting in January. Special and field meetings may be called by the Council.

ARTICLE X.

FEES.

The initiation fee shall be one dollar; the annual fee one dollar. Members in arrears for one year shall, after due notification by the Treasurer, be dropped from the rolls. No member in arrears shall be entitled to vote at the annual meeting for the election of officers.

ARTICLE XI.

AMENDMENTS TO THE CONSTITUTION.

The constitution of the Society may be amended by a two-thirds vote of the members present at any regular meeting, after at least four weeks' notice.

ARTICLE XII.

ORDER OF BUSINESS.

The order of business at each regular meeting, unless otherwise provided by the Council, shall be as follows:

- I. Reading of minutes.
- II. Reports of Committees.
- III. Balloting for members.
- IV. Nominations for membership.
- V. Miscellaneous business.
- VI. Reading of papers, discussions and exhibition of specimens.

Article XII may be suspended at any time by a two-thirds vote of the members present.

PROCEEDINGS.

PRELIMINARY MEETING, November 19, 1880.

In response to a letter of invitation signed by C. V. Riley and G. Brown Goode, ten gentlemen met at the house of the former, No. 1700 Thirteenth Street N. W., to take into consideration a project for the organization of a natural history society in the city of Washington. Capt. C. E. Dutton, U. S. A. was chosen chairman. After an informal interchange of views and a discussion of various propositions advanced by those present, it was decided to send out a call for a general meeting to be held on the following Friday evening, to which all known to be interested in the objects of the proposed society should be invited. The following persons were in attendance at this preliminary meeting: Captain Clarence E. Dutton, Prof. Theodore Gill, Messrs. G. Brown Goode, Ernest Ingersoll, W. H. Patton, Richard Rathbun, C. V. Riley, Frederick W. True, Lester F. Ward, and Dr. George Vasey.

MEETING FOR ORGANIZATION, November 26, 1880.

In response to a call signed by C. E. Dutton, J. W. Chickering, Jr., Theodore Gill, G. Brown Goode, Ernest Ingersoll, W. H. Patton, Richard Rathbun, Robert Ridgway, C. V. Riley, F. W. True, Lester F. Ward, and George Vasey, about thirty gentlemen assembled in the Regents' Room, at the Smithsonian Institution. Prof. Riley was elected chairman, and Mr. Goode, Secretary. After much discussion it was decided to organize a society to be called THE BIOLOGICAL SOCIETY OF WASHINGTON. A committee consisting of Messrs. Gill, Goode, Rathbun, Riley, and Ward was appointed to draw up a form of constitution for the proposed society, and to submit the same at a meeting to be held on the evening of Friday, December 3.

FIRST MEETING, December 3, 1880.

Thirty-five gentlemen assembled in the Regents' Room of the Smithsonian Institution, to hear the report of the Committee appointed to prepare a constitution for the projected society. Prof. Riley acted as chairman and Mr. Goode as secretary. The committee presented its report, and the form of constitution proposed by them was read article by article, and article by article modified and adopted. The constitution as a whole, in the form appended to these proceedings, was then adopted. The Society then adjourned to Friday evening, December 10, at which time a meeting was appointed for the completion of the organization of the Society by the election of a board of officers.

SECOND MEETING, December 10, 1880.

Twenty-two persons met in the usual place. Professor Gill was called to the chair, and, on the motion of Prof. Ward, the Society proceeded to ballot for officers for the ensuing year. The following board of officers was elected :

President—THEODORE GILL.

Vice-Presidents—C. V. RILEY, J. W. CHICKERING, LESTER F. WARD, HENRY ULKE.

Secretaries—G. BROWN GOODE, RICHARD RATHBUN.

Treasurer—ROBERT RIDGWAY.

Members of Council—J. H. COMSTOCK, O. T. MASON, J. H. KIDDER, A. F. A. KING, GEORGE VASEY.

The Society then adjourned to meet on the 24th of December.

THIRD MEETING, December 24, 1880.

The President occupied the chair, and thirty-one members were present.

Messrs. Riley, Goode and King were announced as having been appointed a committee on communications. Dr. Tarleton H. Bean presented a communication entitled NOTES ON A VOYAGE ALONG THE COASTS OF ALASKA AND SIBERIA IN THE SUMMER OF 1880.*

* Published in part in the *New York Times* for September 17, November 21, and December 6, 1880.

FOURTH MEETING, January 14, 1881.

(First Annual Meeting.)

The President occupied the chair and thirty members were present.

In accordance with the recommendation of the Council one of the Secretaries of the Society was instructed to cast the vote of its members for the entire board of officers elected at the meeting of December 10, such having been the understanding at the time of that election. The officers elected at that time were then announced as having been re-elected to serve during the coming year.

The President announced that the Secretary had been authorized to have printed 250 copies of the constitution, with list of officers and members, and requested all members to send in their full names, that the customs of similar societies might be conformed to.

Prof. L. F. Ward read a paper entitled THE FLORA COLUMBIANA OF 1830 AND 1880, which contained comparisons between the list of the plants of the District of Columbia printed in 1830 by Dr. Brereton and the lists perfected by the resident botanists of to-day.*

Prof. D. S. Jordan, of the Indiana State University, read a paper entitled THE SALMON OF THE PACIFIC COAST.†

FIFTH MEETING, January 28, 1881.

The President occupied the chair, and thirty-six members were present.

The President delivered his first annual address upon THE PRINCIPLES OF BIOLOGY WITH REFERENCE TO TAXONOMY.‡

In the discussion of the presidential address, Messrs. Comstock, Mason, Ward, Riley and White participated.

* Included in the following paper :

1882. WARD, LESTER F. Guide | to | the Flora | of | Washington and Vicinity | By | Lester F. Ward, A. M. | — | Washington: Government Printing Office, | 1881. 8vo., pp. 264 + 2, with map = Bulletin of the U. S. National Museum, No. 22. (U. S. National Museum, No. 26.)

† 1881. JORDAN, DAVID S., AND CHARLES H. GILBERT. Observations on the Salmon of the Pacific. <American Naturalist. XV, 1881, (March,) pp. 177-186.

‡ The essentials of this address are embodied in the articles BIOLOGY (Vol. I, 1875,) and MORPHOLOGY (Vol. III, 1877,) in *Johnson's Cyclopaedia*. New York, 1875-8

SIXTH MEETING, February 11, 1881.

The President occupied the chair, and thirty-seven members were present.

An hour was devoted to the completion of the discussion of the presidential address, Messrs. White, Ward, King and Gill taking part. Dr. J. H. Kidder, U. S. N., exhibited a series of photo-micrographs of objects obtained floating in the air of Washington. He also exhibited photo-micrographs of the dry rot fungus from the U. S. Steamer "Portsmouth," after its infection by yellow fever, of spores of various organisms collected in the yellow fever hospitals of Cuba, and of blood corpuscles from patients affected by various febrile diseases.*

SEVENTH MEETING, February 25, 1881.

Prof C. V. Riley, V. P., occupied the chair and thirty-two members were present.

Prof Riley read a paper entitled THE FERTILIZATION OF YUCCA.† Dr. C. A. White gave an account of a collection of fossils, including 1500 species, duplicates of the celebrated collection of James Hall, State Geologist of New York, recently received by the National Museum from the American Museum of Natural History in New York. Mr. Frederick W. True read a paper entitled SUCTORIAL PREHENSION IN THE ANIMAL KINGDOM.‡

EIGHTH MEETING, March 11, 1881.

The President occupied the chair, and thirty-four members were present.

In discussing Mr. True's paper on "Suctorial Prehension" Prof.

* 1881. KIDDER, JEROME H. Report | on | an examination | of the | external air of Washington | by J. H. Kidder, M. D., | Surgeon, U. S. Navy. | — | [Extracted from the Report of the Surgeon General | of the Navy for 1880.] | — | Washington: | Government Printing Office. | 1882. | 8vo., pp. 22 + 1 (+ 1), 10 plates.

† 1881. RILEY, CHARLES V. Further notes on the Pollination of Yucca and on Pronuba and Prodoxus. <Proceedings of the American Association for the Advancement of Science. 1881, Vol. XXIX, Part II, pp. 617-639, figs. 1-16.

‡ To be published in the proceedings of the U. S. National Museum.

Seaman referred to the climbing organs of the Virginia creeper, *Ampelopsis quinquefolia*, and of the so called "suckers" of various sea-weeds, which though perhaps not suctorial in action seem to cling to objects in a manner which is similar to suctorialism. Prof. Riley spoke of a suctorial organ of prehension in the thoracic proleg and anal pseudopod of *Simulium* larvæ and to the ventral branchiæ of the helgramite or dobson, *Corydalis cornutus*, larva, which are suctorial in function. Prof. Gill, speaking of the suctorial powers of young marsupiates stated that he believed them to exert an actual suctorial power, even though the teats be somewhat modified to aid them in clinging. Their first attachment to the teat is purely suctorial, though afterward probably the result of a spasm-like action of the sphincter-oris muscle. He also referred to the suctorial organs possessed by certain bats. Mr. Patton called attention to the peculiar structure of the larva of *Blepharocera* which inhabits torrents and has six segments, each provided with a separate suctorial organ, probably prehensive.

Dr. A. F. A. King read a paper entitled SEPTENARY PERIODICITY IN LIVING ORGANISMS; in the discussion of which Messrs. Prentiss, Riley, Scudder, Ward, and many others participated.

NINTH MEETING, March 25, 1881.

The President occupied the chair, and thirty-five members were present.

Col. Marshall McDonald read a communication ON THE LAWS OF THE RELATION OF PERIODICITY IN DEVELOPMENT TO TEMPERATURE. This paper was discussed by Messrs. Prentiss, King, Busey, Gill and Chickering.

Prof. J. W. Chickering, Jr., read a paper entitled ROAN MOUNTAIN AND ITS FLORA.*

Prof. J. E. Todd read a paper entitled ON THE FLOWERING OF SOLANUM ROSTRATUM, AND CASSIA CHAMÆCRISTA.†

* See 1882. CHICKERING, JOHN W., Jr. Notes on Roan Mountain, North Carolina. < Bulletin, Philosophical Society of Washington. IV. 1881. pp. 60-64. (Flora, p. 63).

† 1882. TODD, JAMES E. On the Flowers of *Solanum rostratum*, and *Cassia chamæcrista*. < American Naturalist. XVI, 1882. (April). pp. 281-287.

TENTH MEETING, April 8, 1881.

The President occupied the chair, except when reading his paper, at which time he was replaced by Vice President Ward. Twenty-three members were present.

Prof. Gill read a paper entitled A CRITICAL REVIEW OF GUNTHER'S STUDY OF FISHES,* and a short discussion upon the merits of this article ensued, participated in by Messrs. Goode, Gill and Ward.

ELEVENTH MEETING, April 22, 1881.

The President occupied the chair, and thirty-eight members were present.

A committee of the Council submitted the following report upon the formation of sections, in accordance with one of the provisions of the Constitution :

The committee recommends, (1.) That five sections be formed as follows : I, Vertebrates ; II, Articulates ; III, Mollusks ; IV, Radiates ; V, Plants. For these sections the following members are suggested as chairmen : I, Mr. Goode ; II, Prof. Riley ; III, Mr. Dall ; IV, Mr. Rathbun ; V, Prof. Ward. (2.) The members of the Society shall be requested to inform the Secretary what section or sections they desire to co-operate with. (3.) New members on joining the Society shall be requested to signify to the Secretary what departments of Biology they are each respectively interested in. Signed by the Committee : C. V. Riley, O. T. Mason, George Vasey, G. Brown Goode, Robert Ridgway.

The President announced that the temporary chairman would be authorized to call meetings of the sections, and that members were expected to hand in their decisions as to the sections which they desire to join.

Dr. George M. Sternberg, U. S. A., Secretary of the National Board of Health, read a paper entitled A FATAL FORM OF SEPTI-

* 1881. GILL, THEODORE. Reprinted from the "Forest and Stream." | — | Günther's | Literature and Morphography of Fishes. | A review of | Dr. Günther's introduction to the | study of Fishes. | — | By Theodore Gill, M. A., M. D., Ph. D., | Member of the National Academy of Sciences, etc., etc. | — | New York : | Forest & Stream Publishing Co., | 1881. 12mo., pp. 16. See also *The Critic*, I, (May 21, 1881,) pp. 132-3; *The New York Times*, May 29, 1881; *Forest & Stream*, XVI, p. 428, (June 30, 1881;) *Science*, VII, pp. 323-6, (July 9, 1881;) *The Nation*, XXXIII, pp. 120-2, (August 11, 1881.)

CÆMIA IN THE RABBIT, PRODUCED BY THE SUBCUTANEOUS INJECTION OF HUMAN SALIVA.*

This paper was discussed by Messrs. Thomas Taylor, Fletcher, King, Comstock, Ward, and Gill.

Mr. Ernest Ingersoll read a paper entitled ON THE MORTALITY OF MARINE ANIMALS IN THE GULF OF MEXICO.*

At the close of the meeting the roll of members was called, and the following persons enrolled themselves as members of the several sections :

Section I. Messrs. Baker, Birney, Clark, Earll, Gill, Goode, Hoffman, King, Mason, Prentiss, Ridgway, N. P. Scudder, C. W. Scudder, Smiley, Thomas Taylor, True, Ward, Wolfley, Fletcher, Flint, Schuermann, Sternberg.

Section II. Messrs. Birney, Comstock, Merrill, Patton, Pergande, Riley, Schwarz, Marx, Howard, and Ulke.

Section III. Messrs. Gill, Sheldon, and Ingersoll.

Section IV. Messrs. Gill and Rathbun.

Section V. Messrs. Comstock, Earll, Goode, Gore, Merrill, Patton, Riley, Schwarz, Seaman, Sheldon, Smiley, Thomas Taylor, Vasey, Ward, Williams, Wolfley, Sternberg, Hawes, Flint, and Hoffman.

FIRST FIELD MEETING, April 30, 1881.

On Saturday, April 30, the Botanical Section held a field meeting at High Island, in the Potomac River, above the Chain Bridge. Seventeen members were present.

TWELFTH MEETING, May 6, 1881.

Vice-President Ward occupied the chair. Twenty-three members were present.

* 1881. STERNBERG, GEORGE M. A fatal form of Septicæmia in the Rabbit, produced by the sub-cutaneous injection of Human Saliva. <Studies from the Biological Laboratory of Johns Hopkins University. II. 1882, pp. 183-200. Plate XIV. (March.)

* 1881. INGERSOLL, ERNEST. On the Fish Mortality in the Gulf of Mexico. IV. <Proceedings, U. S. National Museum, IV, 1881, pp. 74-80.

Prof. Lester F. Ward read a paper entitled A STATISTICAL VIEW OF THE FLORA OF THE DISTRICT OF COLUMBIA.*

Prof. J. H. Comstock read a paper entitled NOTES ON SCALE INSECTS, illustrating his remarks by a collection of specimens.†

THIRTEENTH MEETING, May 20, 1881.

The President occupied the chair. Thirty-one members were present.

Prof. Riley made some remarks upon Prof. Comstock's paper on Scale Insects, and was responded to by Prof. Comstock. Dr. George M. Sternberg, U. S. A., read a paper entitled ON MICROCoccus SEPTICUS‡ illustrating his remarks by photo-micrographs thrown upon a screen by the lantern. This paper was discussed by Messrs. Seaman, Ward, and Taylor.

FOURTEENTH MEETING, June 3, 1881.

The President occupied the chair. Thirty-five members were present. It was announced that after the next meeting the Society would be adjourned until the first Friday in October.

Dr. D. W. Prentiss read a paper entitled THE PHYSIOLOGICAL ACTION OF JABIRANDI, (PILOCARPUS PINNATIFOLIUS.)§

* 1881. WARD, LESTER F. Field and Closet Notes on the Flora of Washington and Vicinity. <Bulletin, Philosophical Society of Washington. IV. 1881. pp. 64-120. (Statistical View pp. 88-104, 116-119.) See also in Bulletin 22 U. S. National Museum, cited above, p. 26.

† 1881. COMSTOCK, JAMES H. Report on Scale Insects. <Report of the Entomologist of the U. S. Department of Agriculture for the year 1880. pp. 235-373. (Scale Insects, pp. 276-349. Plates III-XXII.)

‡ STERNBERG, GEORGE M. A Contribution to the Study of the Bacterial Organisms commonly found upon exposed Mucous Surfaces, and in the Alimentary Canal of Healthy Individuals. <Studies from the Biological Laboratory of Johns Hopkins University. II. 1882. pp. 157-181. Plates XI-XIII: and in Proceedings, American Assoc. Adv. Sci., XXX, 1881.

§ 1881. PRENTISS, D. WEBSTER. Remarkable change of color of the hair from light blonde to nearly jet black in a patient, while under treatment by pilocarpin. Report of pyelo-nephritis, with unusually prolonged anuria. <Philadelphia Medical Times. XI. 1881. (No. 335, July 2, 1881.) pp. 609-12; also reprinted with following title:

— 1. | Remarkable change in the color of the | hair from light blonde to

Mr. G. Brown Goode read a paper entitled THE MACKEREL,* and was followed by Captain J. W. Collins who explained and illustrated the uses of the various kinds of apparatus used in the mackerel fishery.†

FIFTEENTH MEETING, June 17, 1881.

The President occupied the chair. Fifty-two members were present.

Mr. Robert Ridgway exhibited a collection of wild and domesticated turkeys. Mr. Newton P. Scudder made a communication upon the breeding habits of the Painted Tortoise, *Chrysemys picta*. Dr. Thomas Taylor exhibited some specimens of a tapeworm from the common hog.‡ Mr. Frederick W. True exhibited the first volume of the new annual, *Zoologischer Jahresbericht*, published in Leipzig, and compared its merits with those of the London *Zoological Record*. Prof. C. V. Riley exhibited specimens of the seventeen-year locust, and the Rocky Mountain locust, explaining the difference between them and describing their habits.§

The Society then adjourned to the basement of the Smithsonian Building, where Col. Marshall McDonald described some recent

black in a | patient while under treatment by | pilocarpin.—Report of a | pyelo-nephritis, with unusu- | ally prolonged anuria. | 2. | Care of membranous croup treated suc- | cessfully by pilocarpin. | By | D. W. Prentiss, A.M., M. D., | Professor Materia Medica and Therapeutics, National Medical College, Washington, D. C. | — | Printed by | J. B. Lippincott & Co., Philadelphia. | 1881. 8vo., pp. 15+1.

Also—Change in the color of the human hair under the use of pilocarpin. <Cincinnati Lancet and Clinic. XLVI. 1881. (Sept. 3.) pp. 202-205; colored plate and <Proceedings of American Association for the Advancement of Science, XXX, (Cincinnati Meeting,) 1881.

* 1882. GOODE, G. BROWN. Natural History of the Mackerel. <Materials for a History of the Mackerel Fishery in Report U. S. Fish Commission. Part VII for 1881, pp. (1)-(48.)

† 1882. COLLINS, JOSEPH W. (With G. Brown Goode.) The Mackerel Fishery of the United States. Ibid. pp. (49)-(140+.)

‡ 1882. TAYLOR, THOMAS. On a tape-worm from the common hog. <Report of the Commission of Agriculture for 1882, pp.—. (In press.)

§ 1881. RILEY, CHARLES V. The Periodical Cicada *alias* "Seventeen-year Locust." <American Naturalist, XV, 1881, pp. 479-481, one figure.

experiments in fish culture, illustrating his remarks by apparatus in which the eggs of the shad, *Clupea sapidissima*, were in process of hatching. He announced that he had succeeded in keeping shad eggs for twenty-four hours in a half dry condition in moist cloth, and in thus transporting them from place to place, instead of the old cumbersome vessels filled with water.*

Mr. John A. Ryder exhibited, under the microscope, eggs of the shad in various stages of development, and announced the discovery of teeth in shad four or five days old.†

SIXTEENTH MEETING, October 28, 1881.

The President occupied the chair. Thirty-two members were present.

This evening the Society met for the first time in the Archive Room of the National Museum. Prof. Lester F. Ward exhibited a supposed petrification, resembling the hand of a mammal, from near Granger's Station, Wyoming. A discussion followed upon the phenomena of opalization, and the formation of pseudomorphs, in which Messrs. Taylor, Gill, Schaeffer, Dall, and Ulke participated. Mr. Henry W. Elliott read a paper ON THE HABITS OF THE SEA OTTER, (*PUSA LUTRIS*), OF THE NORTHWEST COAST, illustrating his remarks by specimens and sketches on the blackboard.‡

Dr. Thomas Taylor exhibited a new form of freezing microtome, invented by himself, and demonstrated its manner of working.§

SEVENTEENTH MEETING, November 11, 1881.

The President occupied the chair. Twenty-eight members were present.

* See Report of the U. S. Commission of Fisheries for 1881, (Part VIII,) and Transactions of the American Fish Cultural Association for 1882.

† 1882. RYDER, JOHN A. The Protozoa and Protophytes considered as the primary or indirect source of the food of fishes. <Bull., U. S. Fish Comm., I, 1882, pp. 236-251. (Eggs and food of young shad, pp. 248-9.)

‡ To be printed in the forthcoming Census report on the Fisheries of the United States.

§ 1882. TAYLOR, THOMAS. On a new form of freezing microtome. <Proc. Amer. Assoc. Adv. Sci., XXX, (Cincinnati Meeting,) 1881, p. 119.

Prof. C. V. Riley read a paper entitled *ON THE PHILOSOPHY OF THE RETARDATION OF GROWTH AMONG LOWER ANIMALS*.* A discussion followed, participated in by Messrs. Ulke, White, Gill, Earll, King, and Ward. Dr. C. A. White read a paper entitled *ANTIQUITY OF CERTAIN TYPES OF NORTH AMERICAN NON-MARINE MOLLUSCA, AND THE EXTINCTION OF OTHERS*.† This paper was discussed by Messrs. Gill and Dall.

EIGHTEENTH MEETING, November 25, 1881.

The President occupied the chair. Thirty-four members were present.

Mr. Richard Rathbun presented a communication *ON THE RECENT EXPLORATIONS OF THE U. S. FISH COMMISSION*. After sketching the history of the Commission since its organization, in 1871, and describing the new exploring steamer "Fish Hawk," he spoke at some length of the wonderful wealth of life discovered in 1880 and 1881 on the inner edge of the Gulf Stream, about one hundred miles off Newport and Martha's Vineyard. Mr. Rathbun's remarks were illustrated by numerous specimens, and a large model of the steamer "Fish Hawk." Messrs. Gill, Dall, Goode, and Schaeffer took part in the discussion of this paper.

NINETEENTH MEETING, December 9, 1881.

The President occupied the chair. Forty members were present.

Col. Marshall McDonald described some recent observations upon young shad in confinement. Prof. L. F. Ward read a paper on *THE CAUSES OF THE ABSENCE OF TREES ON THE GREAT PLAINS*.‡

* 1882. RILEY, CHARLES V. Retarded Development in Insects. <Proceedings, Amer. Assoc. Adv. Sci., XXX, Cincinnati Meeting, and in separate "Retarded Development, &c.," pp. 4. (February, 1882.)

† 1882. WHITE, CHARLES A. On Certain Conditions attending the Geological Descent of some North American types of Fresh-water Gill-bearing Mollusks. <American Journal of Science and Arts. XXIII. 1882, (May.) pp. 382-6. Annual Report of the U. S. Geological Survey for 1882.

‡ 1882. WARD, LESTER F. On the Cause of the Absence of Trees on the Great Plains. <Kansas City Review of Science and Industry. V. 1882, pp. 697-702. (March.)

Prof. Gill read a paper entitled ON THE AFFINITIES OF THE "GREAT SWALLOWER," *CHIASMODUS NIGER*.* He stated the genus *Chiasmodontidæ*, and not at all allied to the *Gadidæ*. Its first dorsal has inarticulate spines and its ventrals are of the Acanthopterygian type. The group is indeed related to the *Harpagiferidæ* and *Chanichthyidæ* and should have been referred by Dr. Günther to his heterogeneous "family *Trachinidæ*."

TWENTIETH MEETING, December 23, 1881.

The President occupied the chair. Thirty members were present.

Dr. R. W. Shufeldt, U. S. A., read a paper entitled ON THE OSTEOLOGY OF THE GLASS SNAKE, (*OPHEOSAURUS VENTRALIS*).† Prof. Otis T. Mason read a paper entitled THE INVASION OF THE DOMAIN OF BIOLOGY BY ANTHROPOLOGISTS. Mr. Frederick W. True read a paper entitled THE LAND TORTOISES OF NORTH AMERICA.‡

TWENTY-FIRST MEETING, January 6, 1881.

(Second Annual Meeting.)

The President occupied the chair. Thirty-five members were present.

The following officers were elected for the year 1882:

President—Prof. THEODORE GILL.

Vice Presidents—C. V. RILEY, Prof. J. W. CHICKERING, Jr., LESTER F. WARD, and HENRY ULKE.

Secretaries—G. BROWN GOODE and RICHARD RATHBUN.

Treasurer—ROBERT RIDGWAY.

Members of Council—Dr. J. H. KIDDER, U. S. N., Dr. GEORGE VASEY, Dr. T. H. BEAN, Dr. D. WEBSTER PRENTISS, Prof. O. T. MASON.

* 1879. GILL, THEODORE. The Great Swallower. <Forest & Stream. XIII. 1879, p. 906, (Dec. 18,) with figures. (A part only of the remarks made to the Society.)

† 1882. SHUFELDT, ROBERT W. Remarks upon the Osteology of *Opheosaurus ventralis*. <Proceedings U. S. National Museum. IV. 1882. pp. 392-400. Nine figures.

‡ 1882. TRUE, FREDERICK W. On the North American Land Tortoises of the Genus *Xerobates*. <Proceedings U. S. National Museum. IV. 1882. pp. 434-449. Three figures.

TWENTY-SECOND MEETING, January 20, 1882.

The President occupied the chair. Forty-five members were present.

The President delivered the annual address on the topic **THE HISTORY OF CLASSIFICATION IN ZOOLOGY.**

In his introductory remarks he congratulated the Society upon its present flourishing condition, stating that during the year its membership had nearly doubled. He also reviewed the history of other scientific societies of the city, mentioning the National Institute, the Botanical Society, the Potomac Side Naturalists' Club, the Physical Club, and the Geological and Geographical Society, all now extinct, and the existing Philosophical, Anthropological, and Biological Societies. He also spoke of the eminent zoologists who had been, in the early days of its history, identified with the Potomac Side Naturalists' Club, the predecessor of the Biological Society, mentioning the names of Prof. S. F. Baird, Count L. F. de Pourtales, Dr. William Stimpson, Mr. Robert Kennicott, Prof. J. S. Newberry, Mr. H. Ulke, Dr. Harrison Allen, Dr. Elliott Coues, Dr. D. W. Prentiss, Dr. F. V. Hayden, Mr. F. B. Meek, Baron R. von Osten Sacken, Dr. William A. Hammond, Prof. Burt G. Wilder, Dr. George Suckley, Mr. Titian R. Peale, and others.

TWENTY-THIRD MEETING, February 3, 1882.

Prof. Lester F. Ward, V. P., occupied the chair. Thirty-three members were present.

Mr. Frederick W. True read a paper **ON THE ARCTIC SEA COW, (RHYTINA STELLERI.)*** Mr. Henry W. Elliott exhibited drawings of the same extinct animal, and submitted a restoration by himself, the merits of which he advocated.

Mr. Frederick W. True exhibited an immense specimen of *Siren lacertina*, twenty-six inches in length, captured in the mud flats in front of the city of Washington. This species had not previously been recorded north of North Carolina.

* To be published in the forthcoming Census Report on the Fishery industries of the United States.

TWENTY-FOURTH MEETING, February 3, 1882.

The President occupied the chair. Thirty-three members were present.

An animated discussion concerning the form of the tail, as well as the relationship and history of the Arctic Sea Cow, *Rhytina Stelleri*, took place. This was participated in by Messrs. Elliott, True, Coues, and Gill.

TWENTY-FIFTH MEETING, March 3, 1882.

The President occupied the chair. Ninety members were present. Mr. G. Brown Goode, chairman of the Committee on Lectures appointed by the Council, announced that, in co-operation with a similar committee, appointed by the Anthropological Society in response to an invitation from the Council of the Biological Society, a course of lectures had been arranged for; these lectures to be given on consecutive Saturdays, at 3:30 P. M., in the lecture room of the National Museum. These lectures were to be free, and the public was to be invited. The discussion of the form of the tail and affinities of the Arctic Sea Cow was resumed; and by special vote, continued until 10:30 P. M. The speakers were Messrs. Elliott, Coues, True, and Gill.

FIRST SATURDAY LECTURE, March 11, 1882.

An audience of about six hundred were present on the occasion of the first Saturday lecture.

Prof. Theodore Gill delivered a lecture entitled SCIENTIFIC AND POPULAR VIEWS OF NATURE CONTRASTED.*

The introductory address was delivered by Major J. W. Powell.†

* 1882. GILL, THEODORE N. Scientific and Popular Views of Nature Contrasted. <The Saturday Lectures, | delivered in the | Lecture Room of the U. S. National Museum, | under the auspices of the | Anthropological and Biological Societies | of Washington, | in March and April, 1882 | — | D. Lothrop & Co., | 30 and 32 Franklin Street, Boston, Mass. | Washington, D. C.:—Judd & Detweiler, Printers and Publishers. | 1882. | 8vo., pp. (4) 185: (pp. 5-22). Also separately as Saturday Lecture No. 1, with title page, pp. 24.

† 1882. POWELL, JOHN W. Introductory Address (to the Saturday Lectures.) <The Saturday Lectures, pp. 1-3.

 TWENTY-SIXTH MEETING, March 17, 1882.

The President occupied the chair. Forty-five members were present.

Dr. Elliott Coues read a paper entitled ON RECENT ADVANCES IN ORNITHOLOGY, on the occasion of laying before the Society, in advance of publication, a complete copy of the work below cited.* Remarks were made by Messrs. Gill, Ward, and Coues.

Dr. Edward Foreman exhibited a map of the Cretaceous fossil beds of Maryland.

 SECOND SATURDAY LECTURE, March 18, 1882.

About six hundred persons listened to the lecture of Prof. Otis T. Mason on the topic: WHAT IS ANTHROPOLOGY? †

 THIRD SATURDAY LECTURE, March 25, 1882.

An audience of about six hundred persons listened to the lecture by Prof. J. W. Chickering, Jr., on CONTRASTS OF THE APPALACHIAN MOUNTAINS. ‡

 TWENTY-SEVENTH MEETING, March 31, 1882.

Prof. Lester F. Ward, V. P., occupied the chair. Eighty members were present.

Dr. D. Webster Prentiss read a paper entitled MESMERISM IN

* 1882. COUES, ELLIOTT. The | Coues Check List | of | North American Birds. | Second Edition, | Revised to Date, and entirely Rewritten, under Direction of the Author, | with a Dictionary of the | Etymology, Orthography, and Orthoepey | of the | Scientific Names, | the Concordance of Previous Lists, and a Catalogue of his | Ornithological Publications. | [Monogram.] | Boston : | Estes and Lauriat. | 1882.—1 vol., imp. 8vo., pp. 1-165.

† 1882. MASON, OTIS T. What is Anthropology? <The Saturday Lectures, &c., pp. 25-43; also separate as Saturday Lecture No. 2. with title page, 8vo., pp. 21.

‡ 1882. CHICKERING, JOHN W., Jr. Contrasts of the Appalachian Mountains. <The Saturday Lectures, &c., pp. 44-59; also separate with title page as Saturday Lecture No. 3, 8vo., 16 pp.

ANIMALS, and at its close mesmerized a canary bird and a fowl. The paper was discussed by Messrs. Schaeffer, Billings, Ellzey, Coues, Wolfley, Riley, True, King, Gilbert and Gihon.

FOURTH SATURDAY LECTURE, April 1, 1882.

About eight hundred persons listened to the lecture of Major J. W. Powell on OUTLINES OF SOCIOLOGY.*

FIFTH SATURDAY LECTURE, April 8th 1882.

About seven hundred and fifty persons listened to the lecture of Prof. C. V. Riley, on LITTLE KNOWN FACTS ABOUT WELL KNOWN ANIMALS.†

TWENTY-EIGHTH MEETING, April 14, 1882.

The President occupied the chair. Sixty-five members were in attendance. Prof. William H. Brewer, of Yale College, was present as a guest.

Dr. Frank Baker proposed amendments to the Constitution as follows:

In ARTICLE III. Strike out the words, "upon recommendation of the majority of the members present at its regular meeting;" and substitute for the words "a majority vote of the members present when the ballot is taken shall be necessary to an election," the words "seven affirmative votes shall be necessary to an election."

In ARTICLE IV. Strike out the words, "its duty shall be to act on nominations," &c., and substitute—"It shall conduct all the business of the Society except the election of officers."

In ARTICLE XII. Strike out sections III, IV and V.

A committee of five, consisting of Messrs. Ward, Goode, Chickering, Riley, and Rathbun, was appointed to confer with the

* 1882. POWELL, JOHN W. Outlines of Sociology. <The Saturday Lectures, &c., pp. 60-82, also separate with title page as Saturday Lecture No. 4. 8vo. p. 25.

† 1882. RILEY, CHARLES V. Little Known Facts About Well Known Animals. <The Saturday Lectures, &c. pp. 83-112. Also separate with title page as Saturday Lecture No. 5. 8vo., pp. 32. Fifteen woodcuts.

committees appointed by the Anthropological and Philosophical Societies in reference to the proposed scheme for the consolidation of the Scientific Societies of Washington and the formation of an Academy of Sciences and to report the result of their conferences.

Dr. Frank Baker read a paper entitled ON THE RAMIFICATIONS OF THE ARTERIES. This was discussed by Messrs. Gill, Barnard, and Scudder.

Mr. G. Brown Goode exhibited several remarkable specimens of taxidermic skill from the work shops of the National Museum.*

SIXTH SATURDAY LECTURE, April 15, 1882.

About six hundred persons listened to the lecture of Dr. Robert Fletcher upon PAUL BROCA AND THE FRENCH SCHOOL OF ANTHROPOLOGY.†

SEVENTH SATURDAY LECTURE, April 22, 1882.

About six hundred and fifty persons assembled to hear the lecture by Mr. William H. Dall upon DEEP-SEA EXPLORATIONS.‡ Among the audience was Captain Sir George S. Nares, R. N., late commander of the British corvette "Challenger" during its three years cruise of deep-sea exploration.

TWENTY-NINTH MEETING, April 28, 1882.

The President occupied the chair. Forty-five members were present. The Society voted that the next regular meeting of the Society should be a "Darwin Memorial Meeting." A committee

* See Report of the Assistant Director of the U. S. National Museum. <Report of Smithsonian Institution for 1881.

† 1882. FLETCHER, ROBERT. Paul Broca and the French School of Anthropology. <The Saturday Lectures, &c. pp. 113-142. Also as separate, with title page. 8vo., pp. 32.

‡ 1882. DALL, WILLIAM H. Deep-Sea Explorations. <The Saturday Lectures, &c. pp. 143-162. Also separate, with title page, as Saturday Lecture No. 7. 8vo., pp. 22.

consisting of Messrs. Goode, Riley, Ward, Rathbun, and Gill, having been appointed by the Council to arrange for the same, and having anticipated the action of the Society by making certain preliminary arrangements.

Mr. Edmund B. Wilson, of Johns Hopkins University, a corresponding member, presented a paper on THE EMBRYOLOGY OF RENILLA.*

Mr. Frank H. Cushing spoke on the topic ZUÑI BIOLOGY, describing some of the peculiar plants and animals occurring in the deserts of the Southwest, and referring to the manner in which animals are regarded by the Zuñi Indians.

EIGHTH SATURDAY LECTURE, April 29, 1882.

About six hundred persons listened to the lecture of Dr. Swan M. Burnett upon the topic HOW WE SEE.†

SPECIAL MEETING, May 5, 1882.

The President occupied the chair. Thirty-eight members were present.

Mr. Goode presented the report of the Committee on the Darwin Memorial Meeting, which was accepted. Prof. Ward submitted the report of the Committee on the Consolidation of the Scientific Societies in Washington, as follows:

The joint committee composed of the several committees appointed by the Philosophical, Anthropological, and Biological Societies of Washington to consider the desirability of a federation of those societies—

Recommend to the several societies a federation on the following basis, and for the purposes set forth:

* The remarks of Mr. Wilson were in part included in the following papers: 1880. WILSON, EDMUND B. The Early Stages of Renilla. <American Journal of Science, XX, 1880, pp. 446-9, plate VII.

1882. WILSON, EDMUND B. On Animal Polymorphism. <Johns Hopkins University Circulars, No. 15, May, 1882, pp. 203-4.

† 1882. BURNETT, SWAN M. How We See. <The Saturday Lectures, &c. pp. 163-185. Also separate, with title page. 8vo., pp. 25. Three woodcuts.

- I. The purposes of this federation shall be—
 First, the publication of a common body of transactions;
 Second, periodic meetings of the united societies;
 Third, the management of courses of popular lectures; and,
 Fourth, such other objects as may be agreed upon.
- II. The federation shall be known as the Washington Academy of Sciences.
- III. The several societies shall retain their own organizations, excepting as hereinafter modified.
- IV. The three societies shall have the same annual fees of membership.
- V. The uniform fee for each of the three societies shall be three dollars.
- VI. The Academy shall be organized by the election of a president, a secretary, a treasurer, and two councilmen, by the Academy. The presidents of the several societies shall be *ex officio* vice presidents of the Academy, and members of its council, one secretary from each society shall be a member of the council, and each society shall elect two additional councillors for the council of the Academy.
- VII. A grade of fellowship shall be established in the Academy.
- VIII. The annual fee of fellowship shall be five dollars.
- IX. The existing members of all the societies shall be fellows of the Academy, on the payment of the fellowship fee.
- X. The council of the Academy may subsequently elect fellows from the members of the Academy.
- XI. The fellows of the Academy shall be *ex officio* members of all the societies.
- XII. It is recommended to the several societies that the existing committees of conference be continued, for the purpose of collecting the sense of the said societies on the above propositions, and of carrying out such scheme of organization as may be mutually accepted.

WILLIAM B. TAYLOR,
Chairman of Joint Committee.

Committee of Philosophical Society.—John W. Powell, Theodore Gill, James C. Welling, John S. Billings, William B. Taylor.

Committee of Biological Society.—Lester F. Ward, G. Brown Goode, Charles V. Riley, Richard Rathbun, John W. Chickering.

Committee of Anthropological Society.—John W. Powell, Garrick Mallery, James C. Welling.

Mr. Goode submitted the following table of statistics, showing the comparative membership in the three societies:

Total membership in the three Societies.....	329
Membership in Philosophical Society.....	160
“ Anthropological Society.....	115
“ Biological Society.....	134
Common to all.....	22
“ Philosophical and Anthropological Societies ---	32
“ Philosophical and Biological Societies.....	38
Anthropological and Biological Societies.....	36
Members of Philosophical Society only.....	97
“ Anthropological Society only.....	61
“ Biological Society only.....	20

The reports of the committee were discussed by Messrs. Wilson, Bean, True, Riley, Kidder, Seaman, and Ellzey, a strong feeling of opposition to any scheme of consolidation being manifest. The motion of Prof. Riley, “*Resolved*, That it is the sense of this (informal) meeting that a federation with the Anthropological and Biological Societies is desirable,” was carried by a vote of 22 to 8. The first six articles of the report of the committee were provisionally approved one by one, and the committee was continued, with instructions to report further action at a regular meeting of the Society.

THIRTIETH MEETING, May 12, 1882.

DARWIN MEMORIAL MEETING.

The President occupied the chair. In addition to the members of the Society, the members of the other societies and their friends had been invited to attend; and although the night was stormy, about seven hundred ladies and gentlemen were present to attend the memorial service in honor of Charles Darwin, who died at Down, Kent, England, April 19, 1882. On the stage sat, in addition to the officers of the Society, Dr. W. B. Taylor, President of the Philosophical Society; Major J. W. Powell, President, Dr. Robert Fletcher and Prof. O. T. Mason, Vice-Presidents, and Col. F. A. Seely, Secretary, of the Anthropological Society. A large portrait of Darwin, painted by Henry Ulke, V. P., and a bust, by Mrs. Mica Heideman, decorated the stage. The order of exercises was as follows:

Introductory	Theodore Gill.
Biographical Sketch.....	Wm. H. Dall.
The Philosophic Bearings of Darwinism	John W. Powell.

Darwin's Coral Island Studies	Richard Rathbun.*
Darwin's Investigations on the Relation of Plants and Insects	Charles V. Riley.
Darwin as a Botanist	Lester F. Ward.
Darwin on Emotional Expression	Frank Baker.
A Darwinian Bibliography	Frederick W. True.
A Portrait of Darwin	Henry Ulke.

The addresses delivered on this occasion are printed in full in the appendix.

THIRTY-FIRST MEETING, May 26, 1882.

The President occupied the chair. Thirty-five members were present.

Mr. Wm. H. Dall made an appeal for aid in the exploration of the molluscan fauna of the District of Columbia.

Dr. Tarleton H. Bean exhibited a specimen of a rare arctic bird, the Spoon-billed Sandpiper, *Eurynorhynchus pygmaeus*, obtained by him on the coast of Siberia.†

Dr. M. G. Ellzey made a brief communication upon the natural history of mules.

The Society ratified the action of the council in voting that the proceedings of the Society, together with the addresses at the Darwin Memorial Meeting, should be printed, and that the funds of the Society now in the treasury should be used for that purpose. A resolution to the effect that women should be admitted to membership in the Society was referred to a committee consisting of Gen. William Birney, Messrs. Dall and Goode, and Doctors Prentiss and Kidder.

The Society then adjourned to meet in October.

* Omitted on account of the illness of Mr. Rathbun.

† 1882. BEAN, TARLETON H. Notes on Birds collected during the summer of 1880, in Alaska and Siberia. <Proc. U. S. Mus., V, 1882, pp. 144+ (*E. pygmaeus*, p. 165.)

Also, 1881. BEAN, TARLETON H. Our unique Spoon-billed Sandpiper. <Forest and Stream, XVI, April 12, 1881.

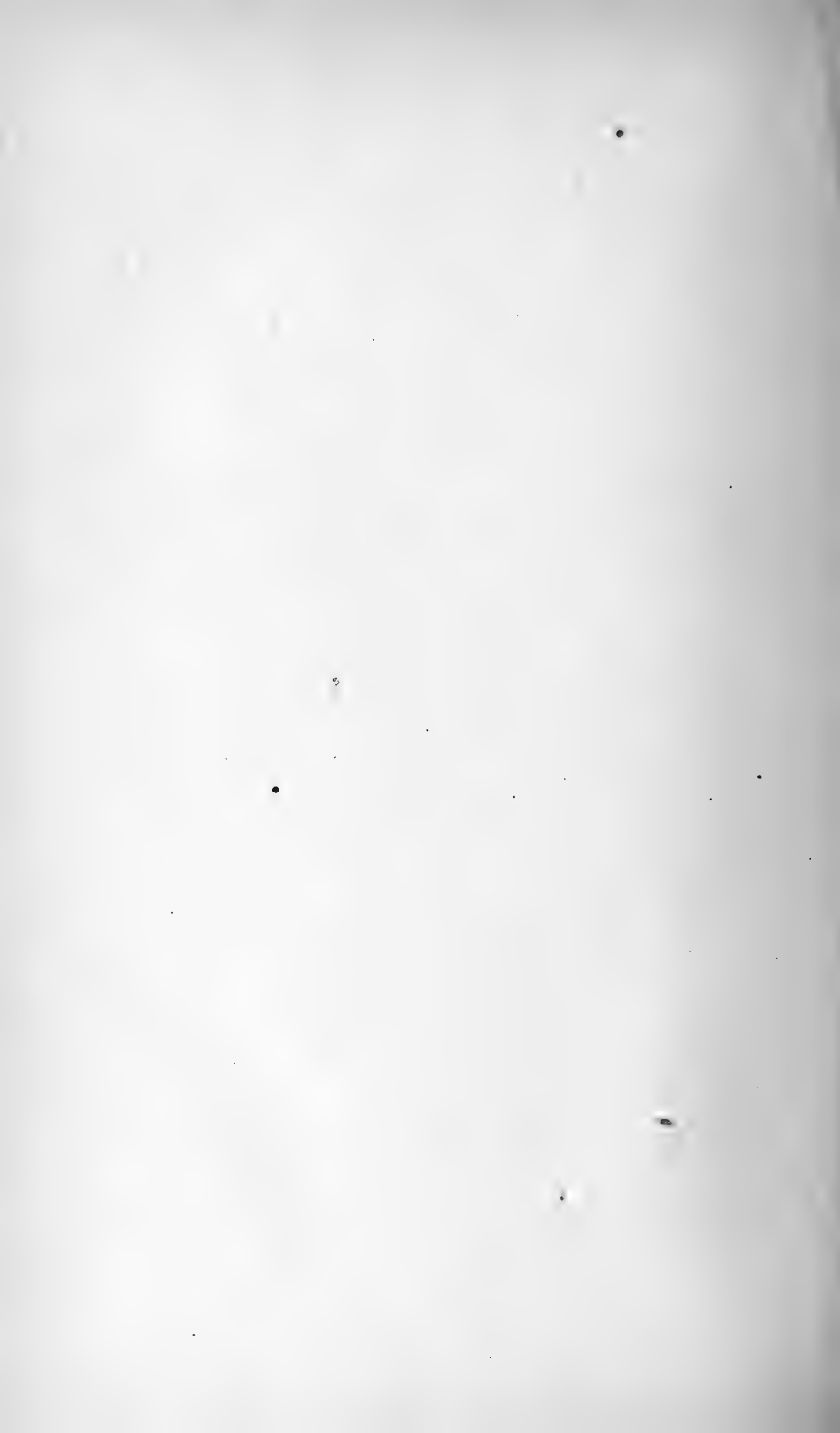
ADDRESSES

DELIVERED ON THE OCCASION OF THE

DARWIN MEMORIAL MEETING,

HELD IN THE LECTURE-ROOM OF THE U. S. NATIONAL MUSEUM,

MAY 12, 1882.



THE DOCTRINE OF DARWIN.*

BY THEODORE GILL.

The chief for many years of the leaders in science knows no longer the world he erstwhile knew so well. CHARLES DARWIN has closed a life illustrious in the annals of biology, scarce full of years but very full of honors.

How fruitful was that life and how potent its influence on philosophy and on sociology the united voice of the civilized world proclaims—how grievous the loss the lamentations of mankind testify. Less than a quarter of a century has elapsed since the publication of the “Origin of Species by means of Natural Selection.” How great is the contrast between the beliefs and practice of naturalists before its appearance and those of their present successors! He would, indeed, have been a bold man who would have predicted that, in two decades after its appearance, the views therein promulgated would be universally accepted and be taken as the recognized platform of biologists. But the incredible has actually happened; all the students of nature, and in every land; zoologists and botanists, palæontologists and geologists—in America and Europe, at the confines of Asia, the extreme of Africa, and in distant Australia—all meet on common ground as evolutionists; all recognize to a greater or less extent the operation of natural selection in the survival of the fittest. To appreciate the cause of the profound impression produced by the deceased naturalist’s greatest work, some reference to the antecedent and succeeding conditions is fitting.

It had been, from time immemorial, a generally accepted idea that the living beings which people the globe had, in some mys-

* Several of the paragraphs in this address were published in advance, with a few modifications, in “The Critic,” of New York, for May 6, 1882.

terious manner, been each "created" separately; but how, few ventured to express in words, for the mere attempt to do so conjured up such strange fancies that the intelligent mind drew back in revolt and refused to consider them. Now, it is a recognized scientific creed that the animals and plants which have successively inhabited the earth, were the descendants, with modification, from previous inhabitants since the dawn of life. A glimmer of the truth had now and then occurred to contemplative students. Philosophers had ventured to think that living forms like ancient ones might have descended from them. The investigators in various departments of biology had gradually deduced generalizations which all tended in a similar direction. The taxologists, in their very nomenclature, compared the animal kingdom to a tree of which the principal types were "branches" diverging from a common trunk, while the minor groups were successive offshoots; and the idea of genetic relationship suggested by the various degrees of likeness was expressed in the names conferred on other groups—"tribe," "family," etc. The embryologists had recognized a coincidence between the stages of development of the "superior" animals and the adults of animals inferior in the system. The palæontologists had discovered an approximate coincidence between the successive inhabitants of the earth and the successive stages in the development of the living animals of the same types. The series of facts thus obtained had even, to some extent, been co-ordinated.

All these series of facts were such as would have been the result of the derivation of existing types from previous ones. But the possibility that the seeming was the real did not commend itself to the consideration of naturalists. Instead thereof, it was assumed that the facts were "in accordance with a plan of the Creator;" that the Deity had conceived a few patterns, and that by those he constructed the animals which successively appeared on the globe, to be in time swept off and replaced by others. If answer was made that such was a puerile conception of creation and that it lim-

ited the power of Deity, excessive anger was displayed, and its opponents called infidels and atheists. But even those who doubted whether the accepted views of creation were tenable, hesitated to take the alternative view. An efficient factor in variation remained to be discovered, and a full presentation of the data had yet to be made.

It was in 1859 that the desiderata indicated were supplied in "The Origin of Species by means of Natural Selection." "Variation under Domestication" was compared and contrasted with "Variation under Nature." The "Struggle for Existence" which is the result of the progressive increase of living beings was considered, and "Natural Selection" was designated as the factor which determined the development and existence as "species" of forms which had descended, with modifications, from countless antecedent generations. With the successive changes in temperature and other conditions ensuing in the ever-changing world, the animals and plants which peopled it were compelled to keep pace by corresponding changes in structure, or to give place to others who could adapt themselves to the new conditions.

So much were the views thus enunciated opposed to the current ideas that a brief period of astonished silence ensued, and men felt about before they could realize their full purport, or that such opinions were broached in sober earnest. Then followed on every hand torrents of detraction and abuse. The naturalists of the old school and the priests of revelation met on common ground, and loud and bitter was the denunciation. Numerous were the arguments against the new theory.

But why this great turmoil and uproar? Darwin was not the first to believe that species had been derived and not created. So had philosophers believed before; the grandfather of Darwin believed and urged the belief; a great naturalist at the commencement of the century—Lamarck—boldly and wisely formulated a theory of evolution; the "Vestiges of Creation" took up the view, and gained marked attention in Britain. Even a clergyman of the English

Church, the Savilian professor in orthodox Oxford, the Rev. Baden Powell, in 1855, had considered the "Philosophy of Creation" in a "masterly manner," and Darwin bore testimony that nothing can be more striking than the manner in which the enlightened priest showed that the introduction of new species is a regular phenomenon in contradistinction to a miraculous process. Darwin was not the first even to conceive of the principle of natural selection. An American resident in England, Dr. W. C. Wells, as early as 1813, had recognized the operation of the principle in the distribution of the human race. In 1831, Patrick Matthews also appreciated the principle of natural selection; so Darwin himself witnesses.

It was not, then, the mere enunciation of the theory of evolution, nor of the principle of natural selection, that characterized the "Origin of Species," and drew the attention of mankind to it. It was the recognition of the incessant and universal operation of the factors, the masterly co-ordination of the facts of biology—zoology, botany, anatomy, general morphology, physiology, embryology, palæontology—and geology, the marshalling in orderly array and concentration in one direction of all natural knowledge, the force of the logic, the clearness of the exposition, the judicial candor of the argument that arrested men's attention, and provoked serious consideration of what before had been ignored as being beyond the domain or possibilities of investigation. In the time of Lamarck the world was not ready for a consideration of the question. Lamarck's was the prophesy of intuitive genius—genius the greater in that the facts that had then been garnered were few. The "Vestiges of Creation" was so replete with errors of fact and misconceptions as to attract more attention to the fault of its details than to the logic of its argument. The principle of natural selection had been applied to very special fields by Wells and Matthews; no evidence had been furnished of its wide extension, and it even occupied a subordinate position in the thoughts of those investigators.

The author of the "Origin of Species" was a different man from

his predecessors, and lived in a happier time. The facts had been accumulated and co-ordinated; men were ready to consider the reason why facts were such, and none was better fitted than Darwin—I should rather say none was so well fitted—to arrange and present the facts and to draw the deductions therefrom. Ever a close observer, practiced in many lands, student of all nature—especially skilled as a geologist, a botanist, and a zoologist—endowed with a severely judicial mind, honest above all, none like him had ever grappled with the mystery of creation. For more than twenty years he had pondered on the subject; with impartial severity he had weighed the evidence. He was, perforce, led to the conclusion that all the living had been derived from past forms, with modifications incident to individuality; the sums of the divergencies, small in themselves, became large in the aggregate, became enormous in time. The increasing beings, crowding upon each other, invading each other's domains, struggled for the life into which they were born. Happy were those possessing some slight advantage—strength, swiftness, dexterity, or adaptability resulting from modification of structure—for they could procure place or food at the expense of their competitors, and the characters that gave them victory secured, likewise, the temporary ascendancy of their kind. How great is this variability our domesticated animals attest; how ancient is our globe geology teaches; that the race is to the strong or the cunning observation of inferior nature assures. With known variability, time, and space, what could not result? Which, then, was the more probable that Nature—or, if you will, the Creator—had always operated under law, or that there had been constant interference?

Thus were the issues fairly joined. On the one hand, Creation was the rallying cry; on the other, Evolution and Darwin. But what meant the opposed terms? It is surely but reasonable to ask the question. The evolutionists conceded the reasonableness, and gladly accepted the ordeal. Could less be required of the creationists? In reverential mood would I submit the alternatives. If they repel, blame not me. I have long and fruitlessly searched for better.

Creation implies the actual fashioning of forms in full panoply, and with all the characteristics of their kind. But when it was asked how this had been effected the answer was vague and evasive. Did "elemental atoms flash into living tissues?" Was there vacant space one moment and an elephant apparent the next? Or did a laborious God mould out of gathered earth a body to then endue with life? The questions are surely pertinent, for only by such means can we conceive of creation. But passionate disclaimers and angry denunciations greeted him who would frame such conceptions in exact language. Metaphysical jargon and rhetoric about divine purposes might sophisticate, but could not answer.

Evolution denotes the derivation of living beings from preceding in endless succession. Variation in progeny, limited heredity, and time are its correlatives. These being conceded, the peopling of the globe with its life, past and present, is conceivable.

What was the evidence to support the conflicting conceptions?

For creation it was urged that the universal consensus of mankind supported it; that divine revelation taught it; and that the diversities and specialization of organic forms forbade the idea of their derivation from a common parentage.

The universal consensus of mankind maintained till the sixteenth century the doctrine that the earth was flat; that the sun and other planets circled round the earth; and that the earth was the great centre of the universe. The universal consensus of mankind for thousands of years is not the universal concensus of the enlightened man, nor of the present century.

The teachers of revelation have been often mistaken. Many are they who once were condemned and denounced because their utterances were not in accordance with the opinions of their day, who are now accepted as the champions of a purer religion. One of the wisest priests of England has said that "with a certain class of religionists every invention and discovery is considered impious and unscriptural as long as it is new. Not only the discoveries of astronomy and geology, but steam, gas, electricity, political economy,

have all in their turn been denounced ; and not least, chloroform. Its use in parturition has been anathematized as an infraction of the penalty pronounced on Eve!"* It is not I, but a great clergyman, who expresses such sentiments.

The objection that the differentiation and specialization of organic beings gainsay their derivation from a common source is a most weighty one. In the infancy of our own knowledge it was unanswerable, and the less we know of nature the more we are impressed with these diversities. It is not, however, simply a question of whether evolution is true ; but which is the more probable of two alternatives—that all the phenomena which point in one direction and which could have occurred in natural sequence, have taken place in such sequence ; or that direct creative intervention has ensued again and again, when the same ends could have been produced without such intervention.

Nature was true to her disciple, and herself furnished the replies.

It was contended that if evolution were true, the evidence should be forthcoming in the existence in previous geological epochs of forms of a generalized character intermediate between still earlier ones and later widely separated forms ; and that of such there were very few.

The graves of the distant past gave up their dead, and the ossuaries of our own far West yielded most cogent testimony to the truth. Forms from the eocene and later beds, resurrected by the wand of the anatomist, rising in successive lines behind the wide gaps in the living files, proclaimed that all were of one blood, and showed the genealogy of the contemporaries of man.

Many were the forms thus connected. Few are those that may be mentioned on this occasion. The horse-like animals, the rhinoceroses, and tapirs are so unlike, that proof of their derivation from one source might be thought to be impossible. But as we go back into the ages we find equines with lateral digits and hooflets

*Rev. Baden Powell's *Essay on the Spirit of the Inductive Philosophy*, etc., p. 455.

becoming larger and longer, teeth shorter and more generalized, skeletons less characteristic; rhinoceroses with cutting teeth, and more slender forms; tapir-like animals without the peculiar tapirine teeth, with rhinocerotoid skulls, and with otherwise modified structure; all these accompanied by innumerable other modifications, till finally we are almost at a loss to tell whether it is a horse-like, a rhinocerotoid or a tapiroid animal that is before us, and *they* become lost in earlier forms with special characters of their own. And as we go still further back we are confronted with still other forms that are connected by series projected backward from the ruminants and from the elephantids. We do, in fine, know the genealogy of our own contemporaries—imperfectly it is true, but still we know it.

It was objected that animals were segregated by such very wide intervals that they must be isolated in different branches, and that there could be no community of structure between such branches; they expressed fundamentally different plans of structure.

One by one zoology, anatomy, and embryology supplied the links between the old branches; the branches were at length completely uprooted, and it has even become a matter of simple convention what should be considered major groups. Plans of structure can no longer be claimed to be peculiar to different types.

That branch of which man is the primate—the vertebrates—was supposed to be perfectly unassailable and isolated; but zoology and anatomy have revealed to us amphioxus, and embryology the earlier stages of the tunicates. The evidence is now conclusive that these forms which once appeared to be among the most distant are now the most closely related. The affinities of the tunicates with invertebrates are evident, and thus we may look far back to that time when vertebrates did not exist, but when the common ancestors, from which they and the related invertebrates should diverge, held sway.

It was even pretended that the evidence was insufficient to show that variation was possible or could be propagated.

From every hand testimony was forthcoming. The breeder could

point to every domesticated animal—the horticulturist and pomologist to all cultivated plants—the systematist and zoögeographer to the limits of species which varied with knowledge of their distribution—the palæontologist to the gradation between the extinct forms and widely separated living species, as well as to that between forms which lived in successive earlier epochs.

It was urged that the Darwinian theory was opposed to revelation, and subversive of Christianity.

As students of nature and seekers after truth alone—so far as nature is concerned—we only ask whether the views of Darwin are true or not. But now, from many a pulpit, and from the most enlightened of the clergy, we hear the claim that evolution is in perfect accordance with revelation, and is a witness to the power, prescience, and goodness of God.

It was contended that acceptance of the teachings of Darwin would have a pernicious tendency, and entail riot, lawlessness, and crime in the world.

A long life of singular purity and blamelessness in the person of Darwin was an answer. An unsullied heritage from an ancestor entertaining like views has been transmitted to heirs of his body without flaw. Sons of the great philosopher continue the studies of their great sire, and worthily wear the heavy mantle left to them.

One after another the scientific opponents of evolution became convinced of its verity, or died out. The naturalists of a new generation with one accord accepted “Darwinism” as a starting point for their more profound studies. The methods and aims of biology became changed. Biology became exalted from empiricism into a science. Long before “The Origin of Species” had even “come of age,” acceptance of its teachings had become an essential of scientific creed, and Darwin was acknowledged to have effected a greater revolution in science than any Englishman since the time of Newton. Most meet was it then that he should rest by the side of his great predecessor whose rival he will ever be in fame.

BIOGRAPHICAL SKETCH.

BY WILLIAM H. DALL.

Charles Robert Darwin, son of Dr. Robert Waring Darwin, F. R. S., and Emma Wedgwood, grandson of Dr. Erasmus Darwin and Josiah Wedgwood, was born at Shrewsbury, England, February 12th, 1809. He died of disease of the heart at his residence, Downe Court, Beckenham, Kent, at 4 P. M., April 19, 1882, and consequently had attained the age of 73 years, 2 months, and 7 days. At Shrewsbury his childhood was passed and his education was obtained at the once famous Shrewsbury Grammar School, presided over by the Rev. Dr. Samuel Butler, afterward Bishop of Litchfield and Coventry.

At the age of sixteen he entered the University of Edinburgh (1825) where he remained two years. Even at this early period he had become a student of natural history, and read his first scientific paper before the Plinian Society. It was "On the Movement of the Ova of *Flustra*," one of the incrusting marine corallines.

In 1827 he entered Christ's College, Cambridge, where he graduated as a Bachelor of Arts four years later. Here he fell under the influence of the teachings of Prof. John Stevens Henslow, an excellent botanist, whose instruction doubtless did much to determine the field of study subsequently occupied by his pupil.

In 1831 Captain Fitzroy, R. N., offered to share his cabin with any competent naturalist who would accompany him on his prospecting voyage to South America in H. M. S. *Beagle*, detailed for surveys in that region. Mr. Darwin, then only twenty-two years of age, offered his services with the stipulation that he should control the collections made, and was accepted. The *Beagle* sailed November 27, 1831, from Plymouth, and returned to England on the 2d of October, 1836. During a large part of the voyage Mr. Darwin suffered greatly from sea-sickness, or some difficulty which simulated it, and which, in some form, returned at intervals throughout his whole life, as sudden fits of

illness which prostrated him for days together, and which were followed by long periods of wakeful convalescence. Under the circumstances, the amount of keen and patient observation, the vast accumulation of facts, and the extensive collections obtained by Mr. Darwin during his voyage, appear more marvelous than ever.

After his return his health was much shattered, and his studies more or less interrupted for some years. He took his Master's degree in course, and shortly after his return was elected a Fellow of the Royal Society, (of which his father and grandfather were previously Fellows,) and of the Geological Society, of which last he was made secretary.

In 1839 he published his epoch-making work "A Journal of Researches into the Geology and Natural History of the Various Countries visited by H. M. S. Beagle;" the first of that long series of investigations to which his life was devoted, and the publication of which revolutionized the study of biology, and gave to Darwin a position as a naturalist unparalleled in the history of science.

In the same year, 1839, Mr. Darwin married his cousin, Emma Wedgewood, and retired to the secluded and beautiful district of Kent where, in his country-house of Downe Court, near Orpington, more than forty years of his life were spent. The district is purely agricultural, a plateau of chalk, some 400 feet above the sea, interrupted by the wavy hollows characteristic of the English chalk country, with beech woods here and there on the slopes. His dwelling is one of the old square-built, red-brick mansions of the last century, to which has been added in more recent times a gable-fronted wing, with another square-built wing and pillared portico on the corresponding side. Shut in and almost hidden from the roadway by a high wall and belt of trees it offers ideal seclusion for a quiet student. On the southern side the walled garden opens into a secluded meadow bounded by a tract of underwood through which there is a lovely view of the narrow valley which descends toward Westerham.

Here, and in the by-paths of adjacent woods and meadows, Mr. Darwin was accustomed to take daily exercise with a characteristic regularity. Up to ten or twelve years ago, his tall figure, mounted on a favorite old black horse, was a familiar object in the country lanes. This animal fell and died suddenly one day, after which it was noted that Mr. Darwin rode no more. His invariable hours for walking, in these later years, were seven in the morning, noon, and four o'clock in the afternoon, usually accompanied by one or more of his sons; one of whom, Mr. Francis Darwin, has long been established as a surgeon in the hamlet of Downe. His habits were extremely regular. He rose at six, took a cold plunge bath (which was repeated in the evening), breakfasted alone, and after his first morning walk was usually in his library by 8 A. M. At nine he would spend a little time in the dining-room opening his mail, and in the evening would linger an hour or two in the society of his family, or that of some of his scientific friends who occasionally visited him; but the greater part of his time was spent in his library, his garden, and the adjacent grounds. A few friends, among whom were Sir John Lubbock and Dr. Farr, near residents, were often with him, and with such he was social, frank and ever ready to enjoy a joke or frolic; with all men he was unpretentious, kind, and devoid of any artificiality of manner; but his life was essentially a secluded one, as may be judged from the fact that the news of his death did not reach London until noon of the following day.

Nevertheless, his life was far from solitary, for his family formed quite a colony in itself until the children reached maturity. Two children, a boy and girl, were lost in infancy, one dying in 1842 and the other in 1858, and are buried in the village churchyard of Downe, near by some of the Wedgewoods.

In the family who lived Mr. Darwin was fortunate. His eldest son, William, is a banker at Southampton; the second, George, took high honors at Cambridge, and is now a Fellow of Trinity College and a distinguished mathematician; the third, Frank, having inherited his father's delicate constitution, acted as his secretary; the fourth, Leonard, an officer of artillery, has distinguished himself

in the direction of astronomy ; the fifth, Horace, is an excellent mathematician. One married and one unmarried daughter complete a family whose constant care has always been to relieve its head from any trouble and anxiety.

Mr. Darwin has always been in easy circumstances, financially, so that he could use his time as he chose, without care. When young he pursued field-sports, with the combined interest of the hunter and the naturalist ; in later years he found his chief relaxation in reading popular novels. His work was taken up with great method, and he never wrote for more than two hours at a time.

In 1853 he received the gold medal of the Royal Society for his various works ; in 1859 that known as the Wollaston medal from the Geological Society ; in 1871 he received the Prussian Order of Knighthood "For Merit," and was elected a corresponding member of the Austrian Academy of Sciences ; and in 1878, foreign associate of the French Academy. He received honorary degrees from Leyden and Cambridge, and other scientific honors almost without number.

His death was unexpected. He had been slightly unwell for several weeks, and the weakness of the heart's action was such that he was not permitted to ascend the stairs, but in the main, he was still able to pursue his ordinary routine. On Tuesday morning Sir John Lubbock found him apparently about as usual. That he was seriously ill, was first known in the village Wednesday afternoon by the arrival of his groom on horseback, horse and man reeking with foam, having galloped for ice six miles and back from the nearest point where it could be procured ; but in vain, the relief arrived too late, Charles Darwin had already passed away, surrounded by his family, including several of his sons, Mrs. Darwin, and a married daughter. On the 26th his mortal remains were laid in Westminster Abbey, near by the ashes of Isaac Newton, and were followed to the tomb, not only by dignitaries of Church and State, but by the universal reverence of the scientific world.*

* It is hardly necessary to state that this sketch is a compilation from all the different sources which happened to be available at the time.

DARWIN'S CONTRIBUTIONS TO PHILOSOPHY.

BY JOHN W. POWELL.

Many are the definitions of philosophy. If we wish not to define what is *true* philosophy, but simply to define the term in all its uses when referring to all times and all men, this definition will do: *Philosophy is the explanation of the phenomena of the universe.*

Now, the phenomena of the universe are embraced in many vast categories.

First, we have the constitution of the heavenly bodies, and their real and apparent motions to be explained. What are they, and how came they to be what they are?

Then we have the earth itself; its forms, its lands and seas, its mountains and valleys, its rivers and lakes, the winds which blow about it, the storms which fall upon it, the lightnings that flash athwart the sky, the thunders that roll among the clouds. What are all these things, and whence came they, and why are they? Again, in the constitution of the earth we find rocks with their minerals, and geologic formations with their fossils. What are rocks and minerals, formations and fossils, and whence came they?

Look at the innumerable forms of plants covering the earth with verdure—the whole vegetable kingdom on the land and on the sea; forests, mosses, and confervæ. Who shall explain the meaning of the phenomena of the vegetable kingdom?

The oceans teem with animal life; reptiles crawl over all the land; the hills and the valleys, the mountains and the plains, are all inhabited by beasts; and the air itself is populated. Who shall tell us of all the living things, and then explain life itself?

Turn to the contemplation of man, organized into tribes and nations; man possessed of innumerable languages; man engaged in arts and industries; man endowed with reason and will; man in search of moral principles to guide his conduct. Whence came this man, and whither does he go?

Among all tribes and nations of the globe, and in all times, men have sought to discover the whence, the how, and the why, of all things—the phenomena of the universe.

The explanation of the universe is philosophy.

The philosophies of the world may be classified as—

- I. Mythologic.
- II. Metaphysic.
- III. Scientific.

Mythology and science constitute the two grand systems of philosophy, but between them stands metaphysic philosophy as a stepping-stone from the former to the latter.

In the lower stages of society philosophy is purely mythologic. All savage and barbaric peoples explain the phenomena of the universe by a system of myths. A mythology is always a growth, and among every people there grows up by the employment of diverse and superficial analogies—curious suggestions—a body of mythic explanations which constitute its philosophy.

Among the Wintuns of California the world is three-storied. There is a world—a great chamber—above, and there is this world, and a world below. The waters fall from the world above because the sky, the floor of that upper world, leaks; and the waters come from the world below through the springs that issue from the flanks of the dead volcanoes of that land; so the waters from above and the waters from below meet and flow down the great Sacramento to the sea, where again they divide; the waters from above taking their way to their upper home, and the waters from below taking their way to the lower world.

The mountains were formed by the great mole-god, who crawled under the land and upheaved the mountain ranges that stand on either side of the Sacramento Valley. And so they explain all of the phenomena of the universe, with which they are acquainted, in a system of myths which constitutes the philosophy of the Wintuns.

Now such a system of philosophy, a mythology, is found in every savage and barbaric tribe of the world.

But there came a time in the history of mankind when some of the peoples changed their philosophy—their explanation of the phenomena of the universe—by changing their methods of reasoning.

ORIGIN OF METAPHYSIC PHILOSOPHY.

From three to two thousand years ago Europe, Asia, and Africa established a commerce in ideas—an exchange in philosophies—carried on by the navigation of the Mediterranean. During that and some previous time there were built on the shores of this sea many cities. Through the building of these cities, and through the industries and arts which sprang up therewith, society was re-organized, and placed upon a new basis—tribal society developed into national society—barbarism into civilization.

The peoples of these cities spoke diverse languages, and entertained diverse mythologic philosophies. Through the intercourse which sprang up between them each learned of the philosophy of the other, and the scholars of that day attempted to discover in all of these diverse mythologies a common body of truth upon the theory then widely accepted, that they had all sprung from a common source—a primitive philosophy itself the truth—and that all the philosophies then existing were degenerations therefrom. This line of investigation led to a curious result.

All of the mythologies of the cities of the Mediterranean were found to be baseless—each a fabric of poetic but superficial analogies. In the mental activity of that time many new philosophies were proposed, diverse and contradictory, and the wisest philosophers said, "How shall we know the truth?" And they endeavored to discover some criterion by which truth should be known. This resulted in the development of *formal logic* as a testing machine into which opinions were put for the purpose of sifting truth from error.

Now the machine called logic, the tool of the metaphysician, is curiously constructed. Its chief hypothesis is that man was primitively endowed with fundamental principles as a basis of reasoning, and that these principles can be formulated. These fundamental principles are supposed to be universal, and to be everywhere accepted by mankind as self-evident propositions of the highest order, and of the broadest generalization. These fundamental propositions were called *major* propositions. The machine, in formal logic, was a verbal juxtaposition of propositions with the major propositions at the head, followed by the minor propositions, and from this truth was supposed to flow.

This formal logic of the Aristotelian epoch has lived from that period to the period of science. Logic is the instrument of metaphysics, and metaphysic philosophy, in its multifarious forms, is the product of logic. But during all that time—2,000 years—no truth has been discovered, no error has been detected by the use of the logical machine. Its fundamental assumption is false.

It has been discovered that man is not endowed with a body of major propositions. It is found that in the course of the evolution of mind minor propositions are discovered first, and major propositions are reached only by the combination of minor propositions; that always in the search for truth the minor proposition comes first, and that no major proposition can ever be accepted until the minor propositions included therein have been demonstrated.

The error in the metaphysic philosophy was the assumption that the great truths were already known by mankind, and that by the proper use of the logical machine all minor truths could be discovered, and all errors eliminated from philosophy. As metaphysic methods of reasoning were wrong, metaphysic philosophies were false; the body of metaphysic philosophy is a phantasmagoria.

THE ORIGIN OF SCIENTIFIC PHILOSOPHY.

While metaphysic philosophers have been playing with their logical kaleidoscopes, another body of philosophers have been at

work gathering the materials for the philosophy of science. Their method is to collect facts and to discover their relations, and they accept no conclusions that are not reached by this method. All other conclusions they hold as undetermined or indeterminate.

And now must be given a definition of science. *Science is true discernment, discrimination, and classification of facts, and the discovery of their relations of sequence.* This is a simple statement, but for its full comprehension a little illustration may be necessary.

A savage hears the voice of his fellow-man, he hears the voice of the beast, and of the bird; he also hears the noise of the thunder, and he supposes that the noise is a voice. In these cases he *discerns* noises, but he does not *discriminate* one noise from the other, and supposes them all to be voices, and that the noise of the thunder is the voice of the Thunder Bird. To understand facts we must not only discern, but discriminate.

The next step in the progress of science is classification. Having discerned and discriminated facts, they must be classified—all those of like nature thrown together. All noises made by living beings for conveying intelligence may be grouped into one class and called voices; all noises made by explosions grouped in another class; and so, as we go on discerning, discriminating, and classifying, we collect the materials of philosophy.

But this is not all of philosophy. Facts have genetic relations. If one thing is done something else will follow, and the highest function of scientific philosophy is to discover the order of succession of phenomena—how phenomena follow phenomena in endless procession, how every fact has had its antecedent fact, and every fact must have its consequent fact. This part of science is called *evolution*, and by this expression scientific men mean to be understood that phenomena go on in endless consequences, and that every act has been preceded by some other act, and that every act will be followed by some other act; that the causes of all of the phenomena of the universe that we wish to explain in a system of philosophy run back into the infinite past; that the consequences of all of the

phenomena which we may now observe in the universe will run on into the infinite future. This is evolution.

The statement now given of the three great systems of philosophy is perhaps sufficient for our purposes this evening, and it remains for us to point out the part contributed to scientific philosophy by Darwin, whom we mourn to-night.

When Darwin rose as a light in the scientific world, scientific philosophers had already discovered that the philosophic method of research should include the discernment, discrimination, and classification of facts. At that time the scientific men of the world were engaged chiefly in the collection and arrangement of facts. To some extent they were engaged in discovering their relations of sequence. Important and interesting sequences had been discovered in the vast realm of astronomy; other interesting sequences of facts had been discovered in the realm of geology; some interesting sequences of facts had been discovered in the realm of human history. In the realm of biology, in plant and animal life, the order of succession of facts, the method of evolution, had not been discovered; yet many men were thinking on this subject, many men searching for the method and course of biologic evolution. The facts relating thereto were partly known, and the course and laws of biologic evolution were dimly discerned.

It remained for Darwin to demonstrate the laws of biologic evolution, and the course of the progress of life upon the globe. This he has done in a manner so masterly that there lives not in the world a working biologist, a scientific man engaged in this field of research, who has not directly or indirectly accepted his great conclusions, and the larger body of biologists have accepted them directly.

Let us now go back to the statement that prior to the time of Darwin, scientific men engaged in researches relating to vegetal and animal life were occupied chiefly in the discernment, discrimination, and classification of facts.

Botanists and zoölogists were engaged in describing species, and

classifying species, and this did not always enlist the highest talent: and naturalists had become wearied with discussions over minute differences and obscure resemblances, the origin and meaning of which were not understood.

The discovery, largely made by Darwin, of the laws of succession, or genesis, gave to this department of scientific research a wonderful impetus, and since that day thousands of men have sprung up throughout the civilized world to take part in biologic research.

In this field the greatest talent of the latest time is absorbed. The philosophy of biology satisfies the reason. In the universe of life, system is discovered, and biologists see visions of the origin of living beings and dream dreams of the destiny of living beings.

Had philosophers discovered that the generations of living beings were degenerating they would have discovered despair. Had they discovered that life moves by steps of generations in endless circles—that what has been is, and what is shall be, and there is no progress, the gift of science to man would have been worthless.

The revelation of science is this: Every generation in life is a step in progress to a higher and fuller life; science has discovered *hope*.

Darwin demonstrated what others vaguely believed or dimly saw: The course and methods of biologic evolution. Darwin gave hope to philosophy.

The universe of phenomena may be classed in three great categories.

I. Physical.

II. Biologic.

III. Anthropologic.

Physical phenomena may be thrown into three categories:

1. Molar or mechanical physics; 2. Stellar or astronomical physics;
3. Molecular physics.

Biologic phenomena may be classed as: 1. Vegetal; 2. Animal.

- Anthropologic phenomena may be classed as: 1. Sociologic;
2. Philologic; 3. Philosophic; 4. Psychologic.

To the discovery of the methods and course of physical evolution, *i. e.*, the order of succession in physical phenomena, many great men have contributed. Among these, Newton stands pre-eminent.

The discovery of biologic evolution, *i. e.*, the succession of phenomena in vegetal and animal life, is in like manner due to the researches of many men, but among these Darwin stands pre-eminent. By his discoveries the discoveries of all other biologists have been correlated and woven into systematic philosophy. The methods and course of anthropologic evolution have yet to be systematized. Important discoveries have been made, but this portion of philosophy is yet inchoate.

WORKING HYPOTHESES.

But Darwin's investigations have not ended research or completed philosophy. He brought scientific men to the frontiers of truth, and showed them a path across the border. Yet more than this he did. He pointed out one of the fundamental methods of research. Before his time philosophers talked about deductive methods and inductive methods. Darwin has taught us that both are fruitless.

Deductive methods are the logical or metaphysical methods which have been already described, by which men arrived at conclusions from general principles supposed to be innate in the human mind. The vanity of these methods has already been characterized.

Inductive methods have found their best expression in the Baconian philosophy. By inductive methods men are to collect facts, unbiased by opinions, or preconceived theories. They are to gather the facts, put them together, arrange and combine them to find higher and still higher generalizations.

But there are facts and facts—facts with value, and facts without value. The indiscriminate gathering of facts leads to no important discoveries. Men might devote themselves to counting the leaves on the trees, the blades of grass in the meadows, the grains of sand on the sea shore;—they might weigh each one, and measure each

one, and go on collecting such facts until libraries were filled, and the minds of men buried under their weight, and no addition would be made to philosophy thereby. There must be some method of selecting, some method of determining what facts are valuable, and what facts are trivial. The fool *collects* facts; the wise man *selects* them.

Amid the multiplicity of facts in the universe, how does the wise man choose for his use? The true scientific man walks not at random through the world making notes of what he sees; he chooses some narrow field of investigation. Within this field he reviews what is already known and becomes conversant with the conclusions already reached. He then seeks to discern more facts in this field, and to make more careful discriminations therein, and then to make more homologous classifications; and, finally, more thoroughly to discover the complexity of sequences.

If he attain to success in doing all this his investigations are always suggested by some hypothesis—some supposition of what he may discover. He may find that his hypothesis is wrong, and discover something else; but without an hypothesis he discovers nothing. A scientific man taking up a subject reviews the facts that are known, and imagines that they lead to conclusions that have not yet been reached by others. His imagination may lead him quite astray, yet he follows it, and says "Now if this be true, then there must be certain yet undiscovered facts," and he seeks for them. He may find that which he seeks, or he may find something quite other. If he be an honest thinker, a true philosopher, it matters not to him. He substantiates his hypothesis or constructs a new one. If such hypothesis leads to many new discoveries scientific men accept it, and call it a working hypothesis, and if it still leads on to discovery scientific men call it a theory; and so working hypotheses are developed into theories, and these theories become the fundamental principles, the major propositions of science, the widest generalizations of philosophy.

Sometimes the inductive method—the Baconian method—is said

to have been modified or improved by the addition of the method by working hypotheses, and then modern scientific methods are said to be inductive. With this understanding, it may be said that the deductive methods of metaphysics have been supplanted by the inductive methods of science. It would, perhaps, be better to say that deductive and inductive methods have been superseded by the method of working hypotheses.

Working hypotheses are the instruments with which scientific men select facts. By them, reason and imagination are conjoined, and all the powers of the mind employed in research.

Darwin, more than any other man, has taught the use of working hypotheses. Newton and Darwin are the two great lights of science—the Gemini in the heavens of philosophy; stars whose glory is the brightest of all.

There be good folk in the world who love mythologic and metaphysic philosophy—one or both. In the ears of such the praise of Darwin is not sweet music. Let me beg of such who may be here to consider that we come to-night to praise our dead, and to tell of our love for the man who gave us hope. You and I cannot contend over an open grave, and in my soul I find no cause for angry contention elsewhere. Every man's opinions are honest opinions—his opinions are the children of his own reasoning, and he loves his offspring.

When I stand before the sacred fire in an Indian village and listen to the red man's philosophy, no anger stirs my blood. I love him as one of my kind. He has a philosophy not unlike that of my forefathers, though widely separated from my own, and I love him as one near akin.

Among civilized men I find no one who has not a philosophy in part common with my own; and of those smaller portions of our philosophies which are not alike I see no cause why anger should be kindled between us thereby. They and I are bound together by the same cord of honesty in opinion.

In Darwin's writings I find no word of reproach. Denunciation

and ridicule, greater than any other man has endured, never kindled a spark of hatred in his breast. Wrapped in the mantle of his philosophy he received no wounds, but lived with and loved mankind.

Let us not gird science to our loins as the warrior buckles on his sword. Let us raise science aloft as the olive branch of peace and the emblem of hope.

DARWIN'S WORK IN ENTOMOLOGY.

BY CHARLES V. RILEY.

Charles Robert Darwin was one of the original members of the London Entomological Society, of whom only six are yet living. He always took the keenest interest in the science of entomology, and drew largely from insects for illustrations in support of the theory with which his name will forever be associated. Indeed, I have the authority of my late associate editor of the *American Entomologist*, Benjamin Dann Walsh, who was a classmate of Darwin's, at Cambridge, that the latter's love of natural history was chiefly manifested, while there, in a fine collection of insects; so that, as has been the case with so many noted naturalists, Darwin probably acquired from the study of insects that love of nature, which, first forever afterward, inspired him in his endeavors to win her secrets and interpret aright her ways!

Though he has left no descriptive or systematic work of an entomological character, yet his writings abound in important facts and observations anent insects, and no branch of natural science has more fully felt the beneficial impulse and stimulus of his labors than entomology. Indeed, the varying conditions of life in the same individual or species; the remarkable metamorphoses; the rapid development; the phenomena of dimorphism and heteromorphism; of phytophagic and sexual variation; the ready adaptation to changed conditions, and consequent rapid modification; the great prolificacy and immense number of individuals; the three distinct-

ive states of larva, pupa, and imago, susceptible to modification, as well as other characteristics in insects—render them particularly attractive and useful to the evolutionist, and the changed aspect which natural history in general has assumed since the publication of the “Origin of Species” is perhaps more marked in entomology than in any other branch, for its author helped to replace ridicule by reason. During his voyage on the “Beagle” he collected a very large number of interesting species, especially in Coleoptera, and they formed the basis of many memoirs by Walker, Newman, and White, and particularly by G. R. Waterhouse, who named *Odontoscelis Darwinii* after him. These memoirs were published either in the Annals and Magazine of Natural History, and in the Transactions of the London Entomological Society, or in various entomological periodicals, and I append a list, which, in this connection, it is not necessary to read.

Scattered through his memorable works, a “Journal of Researches into the Natural History and Geology of the countries visited during the voyage of H. M. S. Beagle round the world,” (which is best known by the publisher’s title, “A Naturalist’s Voyage Round the World,”) and “The Origin of Species by means of Natural Selection,” are many interesting entomological facts, and in almost every instance they are illumined by his masterly genius and his keen, penetrating mind. These are so numerous, so varied, and withal so widely dispersed, that I can only make reference, at this time, to a few of the most important and striking of them.

He pointed out the great preponderance of phytophagous over predaceous species in the tropics as exemplifying the relation of the insect and plant worlds, both of which attain their maximum in those zones. Carabidæ are few; Scavengers and Brachelytra very common; Rhyncophora and Chrysomelidæ astonishingly numerous. (Journal of Researches, etc., p. 34.)

He showed by minute observations that the insect faunas of Tierra del Fuego, separated from Patagonia only by the Straits of Magellan, have nothing in common, and he discussed the influence

of primary barriers on the distribution of species, as shown in the marked divergence of the faunas on the eastern and western slopes of the Cordillera. "We ought not," he remarks, "to expect any closer similarity between the organic beings on the opposite sides of great mountain ranges than on the opposite shores of the ocean, except for species which have been able to cross the barrier, whether of rock or salt water." (*Ibid*, pp. 326-7.)

I believe he was the first to draw attention to the paucity of insects on islands, and to establish the principle that the smaller the area, the less favorable it is for the development of insect life. (*Ibid*, p. 391.)

It is a fact of observation that islands predispose to the apterous condition among insects, a fact that is especially noticeable in Kerguelen's Land, as observed by Dr. Hooker, and particularly by our fellow member, Dr. Kidder. Darwin (*Origin of Species*, etc., p. 109,) first suggested the most plausible reason, viz: that the indiscriminate use of wings might prove injurious to an insular species by tempting it out to sea and to destruction, so that the loss of the power of flight is a positive advantage to the species. The argument against this explanation, viz: that insular species should be gifted with strong powers of flight to fortify themselves against being blown to sea in heavy gales, has little force, because either requirement may be fulfilled; and, in reality, where flight is absolutely necessary, as in the majority of Lepidoptera, and flower-frequenting Coleoptera, the wing capacity, in insular species, is actually increased, or correlated with a diminution of bulk; whereas, in those less dependent on aerial progression, natural selection would decrease wing-power, and there would be just such a correlated increase of bulk as is generally the case.

The principle he laid down, that the accidental introduction of organic beings amongst others to whose interest they are hostile, may be a powerful means of keeping the latter in check, and of finally destroying them, finds vivid exemplification in insects, as I have shown in discussing those imported into this country.*

* Second Annual Rep. on the Insects of Missouri, 1879, pp. 8-13.

He gave reasons for the belief (now generally accepted) that the usual gaudy coloring of intertropical insects is not related either to the heat or light of those zones, but rather to the conditions of existence being generally favorable to life.—(Journal of Researches, etc., p. 381.) He has written on the Phosphorescence of Fire-flies, and on the habits of the larva of one of them—*Lamphyris occidentalis*.—(*Ibid*, pp. 29–30.) He discussed the food-habits of stercorivorous beetles, with reference to the origination of a new habit and the power of adaptation to new conditions.—(*Ibid*, p. 490, note.)

At Port St. Julian, Patagonia, he found a species of *Tabanus* extremely common, and remarks: “We here have the puzzle that so frequently occurs in the case of mosquitoes—on the blood of what do these insects commonly feed? The guanaco is nearly the only warm-blooded quadruped, and is found in quite inconsiderable numbers compared with the multitude of flies.” He has discussed the question of hibernation of insects, and shown that it is governed by the usual climate of a district, and not by absolute temperature. (*Ibid*, 98–9.) He gave the first true explanation of the springing power of the Elateridæ when laid on their backs, showing how much depended on the elasticity of the sternal spine. (*Ibid*, p. 31.) He was the first, I believe, to record the exceptional powers of running and of making sound, in a butterfly, viz., *Ageronia feronia* of Brazil.

In his most famous work he lays stress particularly on the following facts and generalizations, for which he draws from insects: the individual differences in important characters; the remarkable manner in which individuals of the same brood often differ, dimorphism and trimorphism being only the extreme exaggeration of this fact; the difficulty of distinguishing between species and varieties; that geographical races are local forms completely fixed and isolated; that representative species are better distinguished from each other than local forms and sub-species; that the species of large genera vary more frequently than those of small genera, and that specific differences in the former are often exceedingly small;

that fecundity does not determine the rate of increase; that the struggle for life is most severe between species of the same genus; that secondary sexual characters are generally displayed in the same parts of the organization in which the species of the same genus differ from each other; that distinct species present analogous variations; that similar structures are often independently developed; the varying importance for classification of the same important organ in the same group of beings; that analogical or adaptive resemblances are misleading for classification; that the great frequency of mimicry among insects is associated with their small size and general defencelessness, as no species furnished with a sting, or other defensive property, is known to mimic other species; the importance of relative position or connection in homologous parts; the remarkable changes of structure effected during development; that adaptation to the conditions of life in the insect larva is just as perfect and beautiful as in the adult animal, and that, consequently, larvæ of different orders are often similar, and larvæ belonging to the same order often very dissimilar; that larval and pupal stages are acquired through adaptation, and not through inheritance; that rudimentary organs plainly declare their origin and meaning.

Finally he brought together a large body of interesting facts in entomology, bearing on the development and perpetuation of mimicry, and of secondary sexual characters—all more or less explicable by, and furnishing convincing argument for, the general theory of natural selection; while he freely acknowledged that he found among insects facts that seemed to be most fatal to the theory. This is especially the case in social insects where the colony contains neuters and sterile females which often differ widely in instinct and in structure from the sexual forms, and yet cannot propagate their kind. This is not the place to enter into a discussion of the subject, and I will simply remark that there are reasons for the belief that, in his candor, he has been led to exaggerate the difficulties in this case.

But Darwin's chief investigation into insect life were in its relations to plant life, and his work "On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the good effect of crossing," as also that on "Insectivorous Plants," are monuments of skill, industry, and lucid exposition.

Entomologists had often noticed the pollen masses of orchids attached to the proboscis of various moths, and in commenting upon the fact had pronounced it "curious." Darwin in this, as in so many other cases, gave meaning to the curious, and brought light out of darkness.

Before his time we find frequent reference to the injury caused to plants by insects, and Sprengel, Gaertner, Herbert, and others had shown that insects were, also, in many cases, beneficial and even necessary to plants, the color, form, odor, secretions, and general structure of which have reference to their necessary insect pollinizers.

Yet their writings had produced but slight impression outside of a limited circle. It remained for Darwin to impress the world with a broader sense of the actual interrelation between the two, and to inspire a number of observers in this field, in all parts of the globe, who are now constantly adding to the rich store of facts we already possess on the subject. I need only refer to the work of Hooker, Bennet, Axell, Delpino, Hildebrand, H. Müller, and others abroad, and to that of Dr. Gray, and Mr. Wm. Trelease at home.

The importance of insects, as agents in cross-fertilization, was never properly appreciated till after Darwin's remarkable work on *Primula*, and his researches on Orchids, *Linum*, *Lythrum*, etc.

He established the principle that "nature abhors close fertilization," and though some less careful observers in this country—exaggerating the importance of their isolated and often inaccurate observations—have opposed his views, the scientific world has been convinced alike by the force of his logic as by the eloquence of his innumerable facts.

We all know how palæontology has verified many of his anticipa-

tions as to missing links being supplied with increased knowledge of the geological record, and in connection with his work on the fertilization of orchids, we have a remarkable instance of similar verification. The nectaries of *Angræcum sesquipedale* were found by him to sometimes reach $11\frac{1}{2}$ inches in length, with only the lowest $1\frac{1}{2}$ inches filled with nectar. He said "there must be moths with probosces capable of extension to a length of between 10 and 11 inches." In *Nature* for July 17, 1873, or some years later, Fritz Müller recorded, through his brother, Herman Müller, the finding of a Brazilian Sphingid having a length of proboscis of 0.25 meters, or between 10 and 11 inches.

I cannot do justice to Darwin's work on Insectivorous Plants within the time to which these remarks have been limited, nor without trenching on the ground to be covered by Prof. Ward. I must be content to remark, therefore, that he demonstrated the new and wonderful fact in physiology that many plants are capable of absorbing soluble matter from captured insects, and that they have special contrivances and sensibilities that facilitate the capture of their prey: in other words, that plants actually capture and digest animal food; for the secretion of *Drosera*, and other insectivorous plants, with its ferment acid belonging to the acetic series, resembles the gastric juice of animals with its pepsin and hydrochloric acid. The fact of absorption demonstrated, it follows that the process would prove serviceable to plants growing in very poor soil, and that it would tend to be perfected by natural selection.

The pleasure Darwin took in observing the habits and ways of insects, and the simple and lucid manner in which he recorded his observations are frequently exemplified in his *Journal of Researches*, and his account of sundry Brazilian species on page 35, and following, may be consulted as an example.

In the same way that he has influenced all lines of thought and investigation, he has influenced entomology. We find everywhere, in his treatment of insects, the same acute perception, the same candor and impartiality, the same clearness of expression, the same

aptitude to get at the significance and bearing of facts observed, as well as the same readiness to deduce a theory which is only equaled by the devotion with which he clings to the truth, whether favorable or unfavorable to the theory.

In the light of Darwinism, insect structure and habit have come to possess a new significance and a deeper meaning. It has, in short, proved a new power to the working entomologist who, for all time, will hold in reverence the name of him who, more than any other man, helped to replace scholasticism by induction and who gave to the philosophic study of insects as great an impetus as did Linnæus to their systematic study.

In his private life Darwin has given us a lesson of patience, courtesy, and consideration, that will be best appreciated by those who have the misfortune to be endowed with more irritable and aggressive natures.

As the above account of Darwin's entomological work is doubtless rather uninteresting to most of those gathered here, I will close, by request, with a few personal impressions.

I have had the pleasure on two occasions of visiting Darwin at his invitation. On the first occasion, in the summer of 1871, I was accompanied by Mr. J. Jenner Wier, one of his life-long friends and admirers. From Mr. Weir I first learned that Darwin was, in one sense, virtually a confirmed invalid, and that his work had been done under physical difficulties which would have rendered most men of independent means vapid, self-indulgent, and useless members of society.

It is eloquent of the indomitable will and perseverance of the man that, during the long voyage on the *Beagle*, he suffered so from sea-sickness that he never fully recovered from the shock to his system, and could not again venture on the ocean. He had, in fact, on his return from the voyage, to go through a long course of hydropathic treatment. We also now know that though he had suffered much for some months past from weakness and recurring fits of faintness, and had been confined to the house, yet as late as

Tuesday evening before the day of his death, at 4 P. M., Wednesday, he was in his study examining a plant which he had had brought to him, and that he read that night before retiring, while as late as the 16th of March, he read two papers on special botanical subjects before the Linnean Society.

The village of Down is fifteen miles southeast of London, four miles from Orpington station on the Southeastern Railway. The country is among the most beautiful agricultural suburbs of London, and I shall never forget the impression of peaceful, quiet seclusion experienced, as we drove from the station and finally through one of those characteristic English lanes, just wide enough for one vehicle, and worn down several feet below the general level—the sense of confinement being enhanced by the luxuriant hedge on either side. This lane skirts the orchard wall for 100 yards and then goes in front of the house, from which it is separated by a grass plot and flint wall overgrown with ivy.

The Darwin residence is a plain, but spacious, old-fashioned house of the style so common in England, and which, with the surrounding well-kept grounds and conservatory, convey that impression of ease and comfort that belong to the average home of the English country gentleman. A noticeable feature is a bow window extending through three stories and covered with trellis and creepers. In Darwinian phrase the environment was favorable for just such calm study and concentration as he found necessary to his health and his researches.

Upon introduction I was at once struck with his stature (which was much above the average, and I should say fully six feet,) his ponderous brow and long white beard—the moustache being cut on a line with the lips and slightly brown from the habit of snuff-taking. His deep-set eyes were light blue-gray. He made the impression of a powerful man reduced somewhat by sickness. The massive brow and forehead show in his later photographs, but not so conspicuously as in a life-sized head of him when younger, which hung in the parlor.

In the brief hours I then spent at Down the proverbial modesty and singular simplicity and sweetness of his character were apparent, while the delight he manifested in stating facts of interest was excelled only by the eagerness with which he sought them from others, whether while strolling through the greenhouse or sitting round the generously spread table.

Going to him as a young entomologist with no claim on his favor, he seemed to take delight in manifesting appreciation. I had occasion in my third report on the insects of Missouri, published in the spring of that year, to discuss the question of Natural Selection in its bearings on Mimicry, as exemplified in two of our North American butterflies, (*Danaïis archippus* and *Limenitis disippus*.) This report I found in his study with many leaves turned down, and he appeared to take especial pleasure in conveying a sense of his appreciation of particular parts.

The few letters which I received from Darwin were in his own hand-writing, which was rapid and better calculated to save time than to facilitate the reading. I take the liberty of reproducing here the first and last as indicating his attitude toward all workers in the field of natural science, however humble or however undeserving of his praise they may have been; and this generous trait in his character will explain, in some measure, the stimulus and encouragement which he gave to investigators:

DOWN,
BECKENHAM, KENT.

JUNE 1, [1871.]

MY DEAR SIR: I received some little time ago your Report on Noxious Insects, and have now read the whole with the greatest interest. There is a vast number of facts and generalizations of value to me, and I am struck with admiration at your power of observation. The discussion on mimetic insects seems to me particularly good and original. Pray accept my cordial thanks for the instruction and interest which I have received.

What a loss to natural science our poor mutual friend, Walsh, has been: it is a loss ever to be deplored.

Pray believe me, with much respect,

Yours, very faithfully,

CH. DARWIN.

SEPTEMBER 28, 1881.

DOWN,
BECKENHAM, KENT.

MY DEAR MR. RILEY: I must write half-a-dozen lines to say how much interested I have been by your "Further Notes" on *Pronuba*, which you were so kind as to send me. I had read the various criticisms, and though I did not know what answer would be made, yet I felt full confidence in the result, and now I see I was right. * * * *

If you make any further observation on *Pronuba* it would, I think, be well worth while for you to observe whether the moth can or does occasionally bring pollen from one plant to the stigma of a distinct one; for I have shown that the cross-fertilization of the flowers on the same plant does very little good and, if I am not mistaken, you believe that the *Pronuba* gathers pollen from the same flower which she fertilizes.*

What interesting and beautiful observations you have made on the metamorphoses of the grass-hopper destroying insects!

Believe me,

My dear sir,

Yours sincerely,

CH. DARWIN.

My own experience in this regard is the common experience, for an interest in natural science was an open sesame to his generous soul. His consideration, without aggression, was the secret of the gratitude and respect which all felt who had the honor to know him, either personally or through correspondence.

His approval of the work of others was coupled with a depreciation of his own, which was very marked on the occasion of my second visit to Europe, in 1875, when I crossed the ocean with his son Leonard on his way from the Transit of Venus expedition. "Insectivorous Plants" was just finished and Darwin was worn and in feeble health, staying, in fact, at Abinger Hall for rest. He was quite disgusted with the book, to use his son's expression, and doubted whether it could prove of sufficient interest, with its long and dry records of experiments, to be read by any one.

*This is a misapprehension. *Pronuba* is an effectual cross-fertilizer, running from flower to flower, and often flying from raceme to raceme with one and the same load of pollen. The omitted passages in this letter refer to the work of a gentleman still living.

DARWIN AS A BOTANIST.

BY LESTER F. WARD.

Appointed by the committee to furnish a brief sketch on this occasion of the contributions of Charles Darwin to the science of plants, I have purposely chosen the title, "Darwin as a Botanist," in order to emphasize the contrast which may be drawn between different classes of botanists, and to do what I can to accustom the public mind to associate with the terms *botanist* and *botany* certain great fields of investigation which are now rarely suggested by these words.

If I had entitled my paper: Darwin's researches into the phenomena of the vegetable kingdom, I fear it might not have occurred to some of you that this great investigator was a botanist, as he is not generally known as such. Yet I fail to see why the science of botany is not fully entitled to receive its share of the dignity and the luster which Darwin's investigations have reflected upon biology in general.

The popular idea of botany, however, is very different from this. Not ignorant people alone, but scientific men as well, place all botanists under two general classes: "Field Botanists" and "Closet Botanists."

The field botanist is one who, being passionately fond of plants and having mastered the rudiments of botany and become familiar with the names and classification of plants, searches the country for new and rare species, and for new localities for old ones, and makes large collections. Success in these objects is his triumph, and occasionally becoming the proud discoverer of hitherto unknown forms of vegetable life, he finds the scientific world quick and generous in awarding him due credit.

The closet botanist is one who, disdaining the boyish pursuit of flowers, devotes himself to the study of the characters of plants as revealed by the herbarium specimens which the field botanist so

copiously furnishes, and by which method he, too, can discover "new species," and obtain prompt recognition. The closet botanist performs the further useful service of "revising" intricate families and genera of plants, unraveling the entanglements of previous authors, and making such changes in the classification and names as are best suited to secure the maximum personal credit.

I need not tell this audience that Charles Darwin belonged to neither of these classes of botanists. A lover of nature, he yet never wasted precious time in the idle pursuit of rarities. Thoroughly familiar with the distinctive characters upon which botanical classification rests, he yet never pursued to any marked extent the investigation of specimens from the *hortus siccus*. I doubt whether a single species of plant was ever named after him by reason of his having either discovered it in a wild state or detected its specific distinctness by the examination of its characters. I even doubt whether he possessed an herbarium, in the accepted sense of the word.

And yet this man has probably contributed more to our real knowledge of plants than any other single botanist.

In what, then, have Darwin's botanical investigations consisted?

There is a little French book entitled "*Voyage d'un Botaniste dans sa Maison*," a title which, allowing for the characteristic hyperbole of the French tongue, suggests the general nature of Darwin's botanical studies. His researches were conducted in his laboratory, in pots of plants at his window, in his aquarium, in his green-house, in his garden. He worked with instruments of precision, recorded his observations with exactness, and employed every mechanical device for making his results reveal important truths, of which the genius of man would seem to be capable.

Darwin looked upon plants as *living things*. He did not study their *forms* so much as their *actions*. He interrogated them to learn what they were *doing*.

The central truth, towards which his botanical investigations constantly tended, was that of the universal *activity* of the vegetable

kingdom—that all plants *move* and *act*. He has, so to speak, *animated* the vegetable world. He has shown that whichever kingdom of organic nature we contemplate, to *live* is to *move*.

He blandly rebukes the vulgar notion that “plants are distinguished from animals by not having the power of movement,” and still more modestly says that “plants acquire and display this power only when it is of some advantage to them.” But is this the whole? Do animals display this power except when it is of some advantage to them? Certainly not.

Darwin shows us that certain parts of all plants are at all times in motion; not merely the molecular activities of their tissues and of the living protoplasm in their cells, but organized movement of parts. Every leaf, every tendril, every rootlet, possesses the power of spontaneous movement, and under nearly all circumstances actually exercises that power.

There are a great many distinct kinds of movement, depending in all cases upon the special advantages thereby gained to the plant. The laws under which these movements take place have received from him an admirable terminology. Most of them are conditioned either by light, by gravity, by radiation, or by insect agency.

We thus have of the first class, *heliotropism*, or movement towards the light; *apheliotropism*, or movement from the light; *diaheliotropism*, or movement at right angles to the source of light; and *paraheliotropism*, embracing such movements as screen the plant from excess of light.

To the second class belong: *geotropism*, or movement towards the earth or into the soil; *apogeotropism*, or movement contrary to the force of gravity; and *diageotropism*, or movement at right angles to the force of gravity.

The third class embraces the so-called *nyctotropic* movements of plants by which they appear to sleep, and which prove to be devices for the prevention of excessive radiation of the plants' heat.

Under the fourth class fall all those wonderful movements which aid the plant in preventing self-and securing cross-fertilization, a

subject of the most absorbing interest, and of which you have already listened to so able a presentation by Prof. Riley from the point of view of the entomologist.

But Darwin's great service has been to show that these varieties of activity are simply modes in which inherent and spontaneous activities manifest themselves under these varying external influences.

His preliminary investigations into the nature of these innate powers of movement were directed to that large class of plants known as twiners and climbers, whose revolving motions were so thoroughly described in his work on "Climbing Plants." It was here that he laid the foundation for those later studies which eventually resulted in that great work, almost his last, on the "Power of Movement in Plants." In this work he demonstrates by an enormous induction that the ample sweeps of the twining plant are but the most obvious manifestations of a class of phenomena which are common to the entire vegetable kingdom.

Amid the varied forms of movement which plants present Darwin has succeeded in finding one fundamental and generic one to which every other may be referred. To this universal form of plant activity he gives the name "circumnutation." Not only twining stems and tendrils, but parts of flowers, tips of growing shoots, caps of penetrating roots and rootlets, radicles, epicotyls, cotyledons, and even full-grown leaves, are incessantly describing circles, ellipses, and other more or less regular geometrical figures; and he conclusively shows that it is out of this primary form of activity that all the more specialized forms already mentioned have been developed. All movements of the parts of plants are thus to be interpreted as modified forms of this innate periodic circumnutation which is common to all plant life. Such modifications are always in the direction of the plant's advantage and may be so great as to become difficult of recognition as forms circumnutation.

I need not labor to convince you that any modification which is an advantage to the plant will be secured by the process of natural selection. It is the glory of the great genius whose labors we are

here to commemorate to have demonstrated this truth to the entire satisfaction of the united scientific world.

Darwin has actually solved the great problem of phytology, so long supposed to be incapable of solution, viz: Why does the root grow downward and the stem upward? Briefly and roughly stated, the answer to this question is that, as the bursting seed pushes out its two germinal points these circumnutate from the first, and thus explore their surroundings for the means of benefiting the plant. To employ Darwin's own word, they "perceive" the advantage that would result from the penetration of the soil, on the one hand, and from the ascent into the free air and sunlight, on the other, and through the pre-Darwinian law of the "physiological division of labor," the one becomes *geotropic* and the other *heliotropic*—the one develops into a radicle and then into a root, while the other develops into an epicotyl and then into a stem.

I will only add to the thoughts already presented that Darwin's discovery of the existence in all plants of an innate and spontaneous mobility belonging to them as forms of organic life, possesses an important ulterior significance.

The law of natural selection, as a fundamental process, has long since passed the stage of discussion. But there has always remained one unsettled question lying at its very base which Darwin himself admitted to be an open one. That question concerns the cause itself of variation. It is granted that, admitting the *tendency to vary*, all the results claimed for natural selection must follow; but many declare that, in this very tendency to vary, there is a mystery as great as the mystery of life itself.

It is only in this work on the "Power of Movement in Plants" that Darwin has really assailed this last fortress of supernaturalism. Not that he has avowed any such purpose, for of this he would have been incapable, but so skilfully and so powerfully has he marshaled the facts that the conclusion follows without being stated. No one can doubt that he perceived this, and I, for one, am convinced that he saw it from afar, and that it was the great end of his labors;

but with his characteristic wisdom he has declined to invoke the *odium theologicum*, correctly judging that the truth must ultimately assert itself.

The tendency to vary, then, is a mechanical result of the proved fact of universal movement coupled with the admitted law of natural selection. By means of the former all plants and growing parts of plants are perpetually exploring their immediate surroundings in search, as it were, for conditions favorable to development. By means of the latter they are able to avail themselves of such favorable conditions when found. Nothing further than this is required to complete the natural explanation of all the phenomena presented by the organic world, and thus, at last, the whole domain of biology is emancipated from teleological fetters, and placed on the high plane of rational investigation.

In conclusion, let me simply say that, while we can but deeply mourn the irreparable loss which science has sustained in the death of Charles Darwin, we have still the highest grounds for congratulation in the fact that he lived to complete that great work which, next to the "Origin of Species," will, I firmly believe, be awarded by posterity the highest place, viz. , "The Power of Movement in Plants;" for, while the former auspiciously opened the great debate by stating the profoundest of all biological problems, the latter has fittingly closed the argument by answering the last objection.

DARWIN ON THE EXPRESSION OF THE EMOTIONS.

BY FRANK BAKER, M. D.

From the tendency of the imagination to magnify the unknown and remote, arises a popular error that to attain eminence a man of science must be able to gather facts from great distances—from the sources of the Nile, and from polar snows. But the near and commonplace are subject to the same laws as the atoms of interstellar space, and true scientific insight may discover in the very dust under our feet secrets hitherto concealed.

Darwin's work upon the Expression of the Emotions is continuous with and supplementary to his larger and better-known treatise on the Descent of Man. As with other matter bearing directly upon the development hypothesis, its publication was deferred as long as possible, in order that the evidence might be fully weighed. Projected in 1838, it was not published until thirty-five years later. One class of objections to the hypothesis was not considered in the main work. It was generally held that, by his emotional expression, man was widely separated from the lower animals. The eminent anatomist, Duchenne, who remains to-day the best authority on muscular movements, merely expressed the views of the time when he stated that no cause could be assigned for facial expression, except the "divine fantasy" of the Great Artificer.

Having projected his work, how does Darwin proceed? From the gentlemen who have preceded me you have learned of his methods. To test the truth of his conceptions he commences a series of most minute and careful observations, omitting nothing within his reach. His most important field is that which is nearest; his own children, his friends and companions, even the dogs that accompany his daily walks, come under that powerful scrutiny. Where, indeed, can we find so perfect an observer? The calm sanity of his mind keeps him equally aloof from egotism and from self-depreciation. A fact is a *fact*, to be stated with the fairness

and openness of perfect daylight. Here is a man who cares more for the truth than for himself. The black spot in man's sunshine, the shadow of himself, seems non-existent for him. He stands by his work, that is enough; if it has worth, well—if not, still well; the elemental drift of action and reaction will continue, the outcome will still be good. As Carlyle has said, "A noble unconsciousness is in him. He does not engrave *truth* on his watch-seal; no, but he stands by truth, speaks by it, works and lives by it."

But not as a fact gatherer do we find him greatest. Many others have struggled with ant-like toil to amass piles of facts which, like the ant-heap, remain but sand after all. Darwin brings to his work an informing spirit, the genius of scientific hypothesis. Breathed upon by this spirit, the dry bones of fact come together "bone to his bone," the sinews and the flesh come upon them, they become alive and stand upon their feet "an exceeding great army." He searches always for the principles which underlie the facts and make them possible, realizing that the *phenomena*, the things which are seen, are temporal and transitory; the things which are not seen, the cosmical forces which govern and control, are eternal.

In his examination of the expression of the emotions he found that both in man and animals they can be referred to three general principles which may be termed habit, antithesis, and nervous overflow. By habit, or repetition, serviceable movements become fixed—involuntary, or semi-voluntary. By antithesis, opposite frames of mind are expressed by opposite actions, even though those actions may not be serviceable. The theory of nervous overflow is that unusual quantities of force generated by the cerebro-spinal system are discharged by unusual channels of expression when the ordinary channels are insufficient.

He finds that emotional expressions are generally direct consequences of anatomical structure, and clearly shows the interdependence of anatomy and physiology. For structure can no more be divorced from function than matter can be dissociated from force. All the complex expressions of grief—from the twitching of the

eyelids and mouth to the shedding of tears—he has shown to depend upon the necessity for preventing engorgement of the eyes during screaming, an act originally useful solely to attract attention. The steps by which he arrived at this conclusion are typical of his method. Starting first with animals, he finds that their expressions of grief are much less complex and various than those of man. They are confined to noises, such as screaming, barking, whining, in higher forms accompanied by changes in facial expression, particularly by contraction of the muscles surrounding the eye. There is a physiological necessity for this, as otherwise the expiratory effort caused by screaming might engorge and rupture the small ocular blood-vessels. By pressing on the lachrymal gland this causes, in some of the higher animals, a flow of tears. What at first was accidental, merely occasioned by the proximity of the gland, becomes at last habitual, and the nervous force automatically follows the line of its accustomed action, causing a flow of tears after emotional excitement, even though no screaming take place. The correctness of this view is supported by the fact that infants do not shed tears until several weeks old, although they scream violently. The functional activity of the lachrymal gland, in connection with grief, is, therefore, later in phylogenetic development. The laws of heredity and adaptation are found to be operating here, as elsewhere, in the domain of life; the supposed gap between the emotions of man and of other animals is successfully bridged over, and another anthropocentric fallacy is consigned to the limbo of ignorant superstitions.

Many expressions of the lower emotions are found to be disfiguring vestiges of acts useful to lower animals for offense and defense, or for obtaining food. These survive—relics of the previous history of our race—as rudimentary organs are preserved long after their use has ceased. The erection of the hair during fear is remotely derived from the same cause that makes puss bristle when attacked and the puff adder swell out when approached. Originally used for the purpose of exciting fear in an enemy by an increase of

size, it now involuntarily accompanies the somewhat changed emotion of which some of the phases are extinct. It is not very rare to find persons who can make the hair over the front of the head bristle at will. Rage is habitually expressed by uncovering the teeth, which is, in the lower animals, an attempt to frighten their enemies by a show of weapons. This expression may become softened and modified to express the milder emotions of contempt and disdain. I have met a lady who has to perfection the rather rare accomplishment mentioned by Darwin of drawing up the upper lip in a triangular notch directly over the canine teeth so as to display them alone, usually on one side at a time. This most expressive gesture of disdain can be performed under the influence of the emotion by many who cannot do it at will.

Of an opposite class are certain higher expressions, which, having arisen later, are not yet entirely fixed. Blushing is one of the most curious of these. It is not found in infants, and varies greatly in frequency and amount in adults, accompanying the sentiment of modesty, almost unknown among animals. The reddening is usually confined to the face and neck. Darwin suggests an ingenious explanation for this. The blood-vessels most exposed to variations of temperature acquire the habit of expanding and contracting—their vaso-motor nerves become more sensitive. The chief expression of personal appearance is in the face; the attention of the mind is, therefore, directed there whenever the emotion of modesty is aroused. This interferes with the ordinary tonic contraction of the blood-vessels, and an excess of blood suffuses the surface.

A remarkable confirmation of Darwin's views is the recent discovery of localized centers in the brain which control emotional expression, and exist in animals as well as in man. It may sometime be possible to read the currents and counter-currents of the brain by means of feature-play with a precision approaching that by which we estimate the force of a distant battery by the play of a galvanometer needle. Many phenomena of expression, which

were obscure before this discovery, can now be satisfactorily explained. Among these are the phenomena of associated movements. It has been stated that the variety and complexity of the movements involved in the simple act of walking are such that it would be impossible ever to perform it were it necessary to *think* what had to be done, and weigh in the judgment the precise amount of force necessary to distribute to each muscle at each moment of the act. It is now known that the cerebral centers which control the separate muscles put in action are closely contiguous in the brain, and that they probably intercommunicate and excite each other in a definite manner, predetermined by habit and heredity. The conscious mind has only to set in motion the subordinate apparatus, when it goes on, and works out the problem with matchless skill, like the system of cogs and eccentrics that produce the intricate pattern in an engraver's lathe. All have noticed the uncouth manner in which children and untrained persons follow with lips and tongue the motions of their hands when using a tool of any kind. Darwin ascribes this to unconscious imitation, but it can be explained more strictly in accordance with his own principles. The facial muscles are actuated from a cerebral center in close proximity to those which move the arms and hands. In the lower animals this is necessary, for the mouth is an organ of prehension, used in strict association with the fore-limbs in seizing prey, and in other acts. As this associated movement became strongly fixed by long habit, it survives with great obstinacy, and though it has not been useful to the race since the historical period, we have yet to caution our children not to put their tongues out when they write.

My limit of time forces me to conclude this hasty and imperfect summary. The practical bearing of these views is not without importance. Physicians have always depended greatly upon emotional expression as a means of diagnosis. Unconsciously the face of the patient reveals his physical state. Yet too much has been left in the empirical border-land of science. *Why* a certain pathologi-

cal state should be indicated by a definite combination of expressions has not always been clearly shown. To-day the whole subject is studied from the point of view of anatomy and physiology. No occult force is admitted, the correlative nerve-supply of muscles and the effect of excitation of nerve-centers are rationally investigated.

Aside from the great special value of the work, of what tremendous import to the race are Darwin's deductions! For he has shown us that our every thought and act mold our physical frames, and through them the generations yet unborn, either to beauty and grace, or to uncouth ugliness and deformity. As the struggle for existence filled the rocks with organisms forever extinct, because not for the highest use, so may we, too, fossilize and outgrow habits and desires of ignoble birth, ascending by the "power of leasts," by that wondrous calculus of nature, to purer and nobler existence. Darwin has taught us that the forces which, acting through countless cycles, have brought us up from formless slime, now remain in our hands to use for good or ill—

"That life is not as idle ore,
But iron dug from central gloom,
And heated hot with burning fears,
And dipt in baths of hissing tears,
And battered with the shocks of doom
For shape and use."

A DARWINIAN BIBLIOGRAPHY.

BY FREDERICK W. TRUE,

Librarian of the U. S. National Museum.

The complete bibliography of Darwinism should contain, not alone the works which emanated from the busy brain and ready pen of Darwin himself, but the many other productions which these called into life. The acquiescences of friends, the objections of critics, the censures of foes, should all be enrolled in their proper places as representing the ripples and counter-ripples in the sea of

thought, produced by the weighty ideas which dropped from the clear mind of the philosopher. It is not to the merits of these, however, that I can call your attention, but only to a few facts relative to the books of Darwin himself.

I would not have you suppose, if, indeed, one could, after the lucid remarks to which you have listened, that the faulty—and, I fear, almost indiscernible—list of published works, which I have attempted to exhibit before you, reveals more than a moiety of Darwin's writings.* A large number of comprehensive papers, pregnant notes, and incisive queries are contained in those store-houses of precise knowledge, the journals of science, and the publications of learned societies. During more than half a century, from the beginning of Darwin's career to its very close, scarcely a year passed in which a number of articles did not issue from his pen. His first paper, on the Ova of Flustra, and another of similar nature, were read before the Plinian Society, of Edinburgh, in 1825. His last note on the Distribution of Fresh-water Bivalves appeared in *Nature* but a few days before his death.

During the first twenty-five years the articles have mostly a geological and zoological bearing, but later botanical and anthropological subjects come into prominence. They were contributed to many publications, including a few American, German, and French journals. The mass of papers, however, are to be found in the Proceedings and Transactions of the Geological Society of London, the Philosophical Transactions, the Philosophical Magazine, the *Annals and Magazine of Natural History*, and *Nature*.

It is in these papers that we first find the germs of many of those more elaborate works, to which general attention has been attracted. Thus the works on the Origin of Species, the Fertilization of Plants by Insects, the Action of Earth Worms, and others were foreshadowed at a time considerably antedating their final appearance.

* The speaker referred to two large scrolls hanging on the lecture room walls, upon which were inscribed a list of Darwin's most important publications.

Darwin seemed to prefer to work out and write out his ideas alone. Once at least, however, he shared the toil with his friend, Mr. Wallace, and later, in several instances, with his sons, Francis and George Darwin.

Regarding the separately published works of Darwin, there is much of interest from the bibliographical point of view. The conscientiousness with which the author profited by the criticisms of others, revising, improving, and extending his generalizations, makes each new edition seem like a separate production. Whole chapters were stricken out and new ones inserted; facts of doubtful character were replaced by others of a more positive nature and more recent acquisition.

Time forbids that I should refer to the details of publication of more than one work. The inquiring student will find his wants satisfied in the several lists which have already been published.

I will give the history of but one work, the most important of all, the "Origin of Species by Means of Natural Selection." The first edition of this work received the signature of the author on November 24, 1859, and was published the same year. The second edition, which appeared soon after, "was little more than a reprint of the first." "The third edition was largely corrected and added to, and the fourth and fifth still more largely." The sixth edition, which appeared in 1872, was likewise largely amended, and had reached its twenty thousand in 1878. In the meantime foreign editions and translations began to appear. The American and French editions at first kept pace with the English, the second American being from the second English, and the third French from the third English. The Germans, coming in a little later, published their second edition from the third English, and their third, from the fourth English one. The last editions in all these languages were derived, I believe, from the sixth English one. "The Italian is from the third, the Dutch and three Russian editions from the second English editions, and the Swedish from the fifth English edition."

At least twelve of the more important works have been issued in one or more editions in German and French, and a number in other European languages as well.

The sage of Down was undoubtedly honest in his surprise at the ever-extending circle of his influence. A wider and more intelligent audience could scarcely be desired. The number of books in which his opinions are discussed or alluded to is legion. As the illustrious Asa Gray has remarked, "Dante literature and Shakespeare literature have been the growth of centuries, but Darwinism filled teeming catalogues during the life time of the author."

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APPENDIX.

THE PROPER USE OF THE TERM BIOLOGY.*

BY THEODORE GILL.

From the Presidential Address delivered January 28, 1881.

The father of modern natural history, following in the footsteps of his predecessors, recognized three kingdoms of nature, and allowed them equal rank in his scheme of classification. These were severally the subjects of the sciences designated as mineralogy, botany, and zoology. The contrasts between the characteristics of the first and the last two, and the generalities which have since compelled us to employ a term in common for botany and zoology, were not then appreciated. The same method and the same system of terminology were used by Linnæus for the description of the mineral as for the vegetable and animal kingdoms. Nevertheless suggestions had been made still earlier towards a segregation under a common head of the kingdoms of organic nature.

As early as 1587, Cristofle de Savigny, in a scarce and little-known work (*Tableaux accomplis de tous les arts libéraux*, Paris,) contrasted the organic kingdoms under a common denominator, *psychologie*, now universally accepted with a very different signification. The suggestion in question, however, fell still born. It was not till 1802 and 1803 that a term destined to general adoption was proposed. Then the illustrious Lamarck made use of the word BIOLOGIE as a common name under which to consider the phenomena presented by organic nature. A number of words were subsequently urged as substitutes and as better, *e. g.*, *Somilogie* by Rafinesque, in 1814; *Physique Organique* by Comte, in 1830; *Organomie* by d'Omalius d'Halloy, in 1838; *Zoologie* by Jean Reynaud, in 1843; *Organologie* by Gerdy, in 1844; and, lastly, *Zoonomy* by Baden Powell. None of them, however, have been received with favor, and, slowly at first, afterward by general consent, BIOLOGY was accepted as a term much needed to group the many generalities enunciable respecting animals and plants. The old professorships of natural history or of zoology and botany combined are now being replaced by professorships of biology, and almost *pari passu* with excessive (because exclusive) cultivation of special departments of botany and zoology has been a tendency to combine on common ground to consider the general laws and principles affecting alike the organic kingdoms of nature, and by students agreeing in the method which they employ in their several pursuits. As a result of this feeling has been born the BIOLOGICAL SOCIETY OF WASHINGTON.

*Much discussion having attended the consideration of a name for the "Biological Society of Washington" the subject was treated of in the first presidential address, and that portion thereof relating to the question at issue is here reproduced.

The applicability of the term biology, in the sense now so generally accorded to it, is doubtless debatable, and has been strongly objected to by an eminent scholar, Baden Powell. That gentleman, in the first essay of his "Order of Nature," (§ 4, p. 173, note,) while discussing the "Theory of Life" and "Life in Geological Epoch," has uttered a protest against the use of the word in the following terms :

"While on this subject I cannot omit to take this occasion of recording my protest against the now prevalent, but barbarous use of the term 'Biology.' *βίος* never means 'life' in the sense of 'vitality;' it means the 'life' of a man as progressing in *time*—his birth, actions, and death. Plato has '*βίος ζωῆς*,' the lifetime of a life. (Epinomis, [or the Philosopher,] 982.) Unfortunately the term 'Zoology,' which would be the proper one for this branch of science, has been already appropriated to what ought to have been called 'Zoography;' but there is still 'Zoonomy,' the science of the laws of life, open to adoption, and, at any rate, much better than '*biology*,' which, if it means anything, would be a theory of the facts of *biography*.'"*

On the other hand, a still more eminent and probably better scholar in Greek philology, William Whewell, has preferred the term biology to any other. In his "History of Scientific Ideas," under the caption of "The Philosophy of Biology," (Vol. 2, p. 170,) he urges that "the word *Physiology*, by which they [that is, to use again his own words, 'the organical sciences'] have most commonly been described, means the *science of nature*; and though it would be easy to explain, by reference to history, the train of thought by which the word was latterly restricted to *living nature*, it is plain that the name is, etymologically speaking, loose and improper. The term *biology*, which means exactly what we mean to express, *the science of life*, has often been used, and has of late become not uncommon among good writers."

It may be added that the word *βίος*, although doubtless generally used in the sense of lifetime, as urged by Baden Powell, nevertheless does not appear to have been limited to such meaning, but to have had practically the same range as our word life. Even if it were so limited, however, it would be eminently appropriate from the standpoint from which all scientific students of nature now take view, for it is the lifetime of nature and the questions of how organisms have been evolved and how grown and developed that must interest the students of life, plants and animals, as well as those organisms neither plants nor animals that formerly existed and still survive.

It is in fact the sum of those phenomena which may be aptly described as constituting the lifetime of nature that forms the true aim of what may, with the strictest and exact propriety, be called BIOLOGY.

The word seems to have been also used quite generally by entomologists in a very restricted sense; that is, as a common denominator for whatever relates to the special habits and manners of insects in contradistinction to Physiology. Thus Hagen, in his *Bibliotheca Entomologica*, (1863,) groups all entomological

* Powell, Order of Nature, Essay 1, § 4, p. 172, note, Theory of Life.

treatises under eight categories, viz: (1) Accessories and Generals; (2) General Entomology; (3) Special Entomology, *i. e.*, the subordinate groups, orders, etc. (4) Anatomy; (5) Physiology; (6) *Biology*; (7) Benefits from Insects; and (8) Injuries from Insects. This summary will give some idea of what entomologists intend by the word, and the original sense of the word, as indicated by Plato in the connection already indicated, might be used as an argument in justification. There would, indeed, be no strong objection to the use of the word to signify a study of habits had it not been already, by general consent, used in another sense. Our well considered rules, as well in zoology as in botany, that priority determines the use of a name, and that the same name cannot be well used in two different senses, combine with the universal consecration of the term otherwise, to forbid us to use it in the limited sense indicated.

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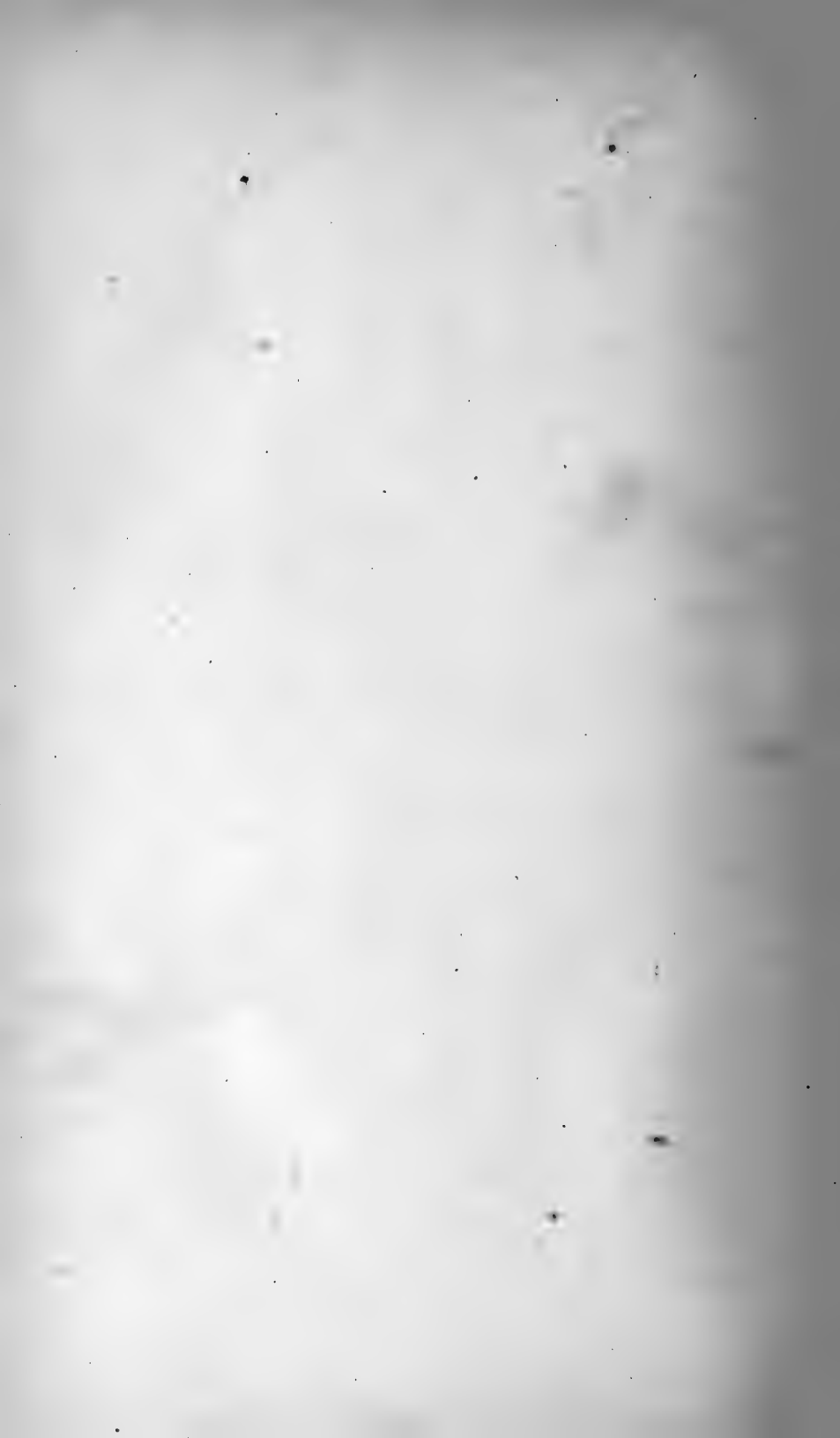
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TRANSACTIONS
OF THE
ANTHROPOLOGICAL SOCIETY
OF WASHINGTON.

FOR THE FIRST, SECOND, AND THIRD YEARS OF ITS ORGANIZATION.

PUBLISHED WITH THE CO-OPERATION OF THE SMITHSONIAN INSTITUTION.

VOLUME I.

FEBRUARY 10, 1879, TO JANUARY 17, 1882.

WASHINGTON:
PRINTED FOR THE SOCIETY.
1882.



COUNCIL AND OFFICERS
OF THE
ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

ELECTED JANUARY 17, 1882.

COUNCIL.

J. W. POWELL, *President*.

SWAN M. BURNETT.	A. F. A. KING.
EDWARD ALLEN FAY.	GARRICK MALLERY.
ROBERT FLETCHER.	OTIS T. MASON.
G. K. GILBERT.	MILES ROCK.
J. HOWARD GORE.	F. A. SEELY.
H. W. HENSHAW.	LESTER F. WARD.
W. J. HOFFMAN.	J. C. WELLING.

OFFICERS.

PRESIDENT.

J. W. POWELL.

VICE PRESIDENTS.

SECTION A, <i>Somatology</i> ,	ROBERT FLETCHER.
SECTION B, <i>Sociology</i> ,	J. C. WELLING.
SECTION C, <i>Philology, Philosophy, and Psychology</i> ,	GARRICK MALLERY.
SECTION D, <i>Technology</i> ,	OTIS T. MASON.

SECRETARIES.

GENERAL SECRETARY,	LESTER F. WARD.
SECRETARY TO THE COUNCIL,	F. A. SEELY.

TREASURER.

J. HOWARD GORE.

CURATOR.

W. J. HOFFMAN.

PUBLICATION COMMITTEE.

J. W. POWELL, LESTER F. WARD, J. HOWARD GORE.



HISTORICAL NOTICE.

THE preliminary meeting which led to the formation of the ANTHROPOLOGICAL SOCIETY OF WASHINGTON was held in the Regents' Room of the Smithsonian Institution on Monday evening, February 10, 1879, in response to the following call through the public press:

“WASHINGTON, *February 7, 1879.*

“Many persons interested in American Archæology have expressed a desire for an organization in this city to promote study and diffuse knowledge upon the subject. All willing to join an Archæological Association are requested to attend a meeting at the Smithsonian Institution on Monday evening, 10th instant, at 7½ o'clock, for a conference upon the subject, and the formation of such a society.

“J. M. TONER, M. D.,

“OTIS T. MASON, Columbian College,

“GARRICK MALLERY, U. S. Army.”

The following gentlemen responded to this call by attending the preliminary meeting:

Dr. A. Wellington Adams, Mr. S. Yorke At Lee, Prof. S. F. Baird, Mr. Otis Bigelow, Mr. George H. Boehmer, Mr. E. A. Burdick, Mr. Frank H. Cushing, Dr. Wills DeHass, Dr. Robert Fletcher, Mr. G. Brown Goode, Mr. John C. Lang, Col. Garrick Mallery, Prof. Otis T. Mason, Dr. James E. Morgan, Mr. P. W. Norris, Lieut. W. W. Reisinger, Dr. Elmer R. Reynolds, Mr. William J. Rhees, Dr. Miles Rock, Mr. Lenox W. Simpson, Dr. J. E. Snodgrass, Dr. J. M. Toner, Mr. Edwin P. Upham, Mr. Lester F. Ward, and Mr. Joseph M. Wilson.

At that meeting the propriety of such an organization was discussed, as well as the question as to the most appropriate name by which it should be known, and a committee consisting of Dr. J. M.

Toner, Prof. Otis T. Mason, Col. Garrick Mallery, and Dr. Wills DeHass, was appointed to draft a constitution.

The meeting adjourned to reassemble in the same room one week later and consider the report of the committee.

A second preliminary meeting was accordingly held on Monday evening, February 17, and the committee reported a constitution which, after discussion and slight modification, was adopted.

The following is the constitution adopted at that meeting :

ORIGINAL CONSTITUTION.

ARTICLE I.—*Name.*

The name of this Society shall be "THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON."

ARTICLE II.—*Object.*

The object of this Society shall be to encourage the study of the Natural History of Man, especially with reference to America, and shall include Archæology, Somatology, Ethnology, and Philology.

ARTICLE III.—*Members.*

The members of this Society shall be persons who are interested in Anthropology, and shall be divided into three classes : Active, Corresponding, and Honorary. The active members shall be those who reside in Washington, or in its vicinity, and who shall pay the dues required by Article XV ; corresponding members shall be those who are engaged in anthropological investigations in other localities ; honorary members shall be those who have contributed by authorship or patronage to the advancement of Anthropology. Corresponding or honorary members may become active members by paying the fee required by Article XV.

All members shall be elected by ballot, as follows : The name of the candidate shall be recommended to the council, in writing, by two members. If a majority of the Council favor the election, the name shall be presented to the Society, and a vote of a majority of the active members present at a regular meeting shall be necessary to an election.

No person shall be entitled to the privileges of active membership before signing the constitution.

ARTICLE IV.—*Officers.*

The officers of this Society shall be a President, four Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and a Curator, all of whom, together with six other active members, shall constitute a council, all to be elected by ballot at each annual meeting. The officers shall serve one year, or until their successors are elected.

ARTICLE V.—*The Council.*

No business shall be transacted by the Society, and no communication received or published in the name of the Society, that has not first been referred to the Council, five members of which shall constitute a quorum.

They shall act on all nominations for membership, shall have direction of the finances, audit the accounts of the Treasurer, Corresponding Secretary, and Curator, and provide a proper programme for regular and special meetings. They shall meet one hour before the regular sessions of the Society, and at such other times as they may be called together by the President. They may call special meetings of the Society.

ARTICLE VI.—*The Sections.*

For active operations the Society shall be divided into four sections, as follows: Section A, Archæology; Section B, Somatology; Section C, Ethnology; Section D, Philology. The Vice Presidents of the Society shall be *ex officio* chairmen of these sections respectively, and shall be designated by the President to their sections after their election. It shall be the duty of these sections to keep the Society informed upon the progress of research in their respective fields, to make special investigations when requested by the Council, to announce interesting discoveries, to collect specimens, manuscripts, publications, newspaper clippings, etc., and in every way to foster their divisions of the work.

All papers presented to the sections shall be referred to the Council, and through it to the Society.

ARTICLE VII.—*The President.*

The President, or, in his absence, one of the Vice Presidents, shall preside over the meetings of the Society and of the Council, and shall appoint all committees in the Council and in the Society.

ARTICLE VIII.—*The Vice Presidents.*

The Vice Presidents shall respectively preside over the sections to which they have been designated, and represent such section in the Council and in the Society.

All papers from a section shall be referred to the Council through its vice-president.

ARTICLE IX.—*The Corresponding Secretary.*

It shall be the duty of the Corresponding Secretary to receive and answer all letters of the Society, to give due notice of all meetings, regular and special, to receive all donations to the Society other than money, acknowledge the receipt thereof, and deliver them to the Curator.

ARTICLE X.—*The Recording Secretary.*

The Recording Secretary shall keep the minutes of the regular and special meetings of the Society, and of the Council, shall keep a list of active, corresponding, and honorary members, with their residences, and shall inspect and count all ballots.

ARTICLE XI.—*Duties of the Treasurer.*

The Treasurer shall receive and have charge of all moneys; he shall deposit the funds as directed by the Council, and shall not expend any money except as ordered by the Council. He shall notify members in writing when their dues have remained unpaid for six months.

ARTICLE XII.—*The Curator.*

The Curator shall have charge of all books, pamphlets, photographs, clippings, and other anthropological material not deposited in accordance with Article XVI, in the National Museum, or the Army Medical Museum; he shall keep a record of them in a book provided by the Society; he shall keep a card subject-index of anthropological facts, to which the members are all expected to contribute.

ARTICLE XIII.—*Meetings.*

The regular meetings of the Society shall be held on the first and the third Tuesday of each month from October to June, inclusive. An annual meeting for the election of officers shall be held on the third Tuesday of January in each year, at which only active members who are not in arrears for fees shall be entitled to vote. The business of the Society shall be conducted in accordance with the established rules of parliamentary practice. Papers shall be limited to twenty minutes, after which the subject shall be thrown open for discussion, remarks thereon to be limited to five minutes for each speaker. At the first meeting in February the retiring president shall deliver an address upon the work of the Society during the preceding year. Ten active members present at any meeting shall constitute a quorum.

ARTICLE XIV.—*Visitors.*

Members may invite strangers interested in Anthropology to attend any meeting except the annual election; but a resident of the District of Columbia shall not be invited more than once during a year, except with the consent of the Council.

ARTICLE XV.—*Fees.*

Each member, on joining, shall pay the sum of two dollars, and two dollars for each year thereafter, commencing with the first of January ensuing. The names of members failing to pay their fees one month after written notice from the Treasurer, as provided in Article XI, shall be dropped from the roll.

ARTICLE XVI.—*Donations.*

It shall be the duty of all members to seek to increase and perfect the materials of anthropological study in the national collections at Washington. All donations of specimens, books, pamphlets, maps, photographs, and newspaper clippings, shall be received by the Corresponding Secretary and delivered to the Curator, who shall exhibit them before the Society at the next regular meeting after their reception, and shall make such abstract or entry concerning them, in a book provided by the Society, as will secure their value as materials of research; after which all archæological and ethnological materials shall be deposited in the National

Museum, in the name of the donor and of the Society; all crania and somatic specimens, in the Army Medical Museum; all books, pamphlets, photographs, clippings, and abstracts, in the archives of the Society.

ARTICLE XVII.—*Amendments.*

This constitution shall not be amended except by a three-fourths vote of the active members present at the annual meeting for the election of officers, and after notice of the proposed change shall have been given in writing at a regular meeting of the Society, at least one month previously.

ARTICLE XVIII.—*Order of Business.*

The order of business at each regular meeting shall be :

1. Reading the minutes of the last meeting.
2. Report of the Council upon membership.
3. Report of the Corresponding Secretary.
4. Report of the Curator.
5. Reading of papers and discussions.
6. Notes and queries.

The third meeting was held February 24, 1879, at which the officers of the Society for the ensuing year were elected. The following were the officers chosen :

FIRST OFFICERS.

PRESIDENT	J. W. POWELL.
VICE PRESIDENTS	{ J. M. TONER. GEORGE A. OTIS. GARRICK MALLERY. WILLS DEHASS.
CORRESPONDING SECRETARY	OTIS T. MASON.
RECORDING SECRETARY	ELMER R. REYNOLDS.
TREASURER	JOHN C. LANG.
CURATOR	FRANK H. CUSHING.
COUNCIL AT LARGE	{ ALBERT S. GATSCHET. W. W. REISINGER. G. K. GILBERT. CHARLES A. WHITE. THOMAS ANTISELL. J. M. WILSON.

The first Regular Meeting of the Society was held, pursuant to the above constitution, on Tuesday evening, March 4, 1879, and bi-weekly meetings have since taken place regularly, as provided for in Article XIII.

The Regents' Room of the Smithsonian Institution, through the courtesy of Prof. Spencer F. Baird, Secretary of the Institution, was occupied as the place of meeting until January 18, 1881, when the offer of the Faculty of the National Medical College, of the use for this purpose of the lower Lecture Hall of the College was formally considered and accepted, at which place the Society has since met.

During the first three years of the Society, viz., from March 4, 1879, to January 3, 1882, sixty-eight papers were read and three presidential addresses delivered. The number of papers presented in the year 1879-'80, was twenty-seven, the number in the year 1880-'81, was nineteen, and the number in the year 1881-'82, was twenty-two.

Abstracts of most of the papers have been furnished and many of them have been published entire in different ways. The papers read during the first two years were collected together by the President at the end of the second year, and abstracts of them published by him as data for his annual address for that year in compliance with a clause in Article XIII of the Constitution. These abstracts, chronologically arranged, together with the presidential address of the previous year, and that for the second year, with an index, were published by the President under the following title: "Abstract of Transactions of the Anthropological Society of Washington, D. C., with the Annual Address of the President, for the First Year ending January 20, 1880, and for the Second Year ending January 18, 1881. Prepared by J. W. Powell. Washington, 1881."

The whole forms a pamphlet of 150 pages, and constitutes a valuable record of the Society during its first two years. The expenses of this publication were, by a vote of the Society and Council, divided equally between the Society and the President.

The abstracts and addresses published in this work will not be republished in the present volume, but reference will be made in each case to the page on which they occur.

At the annual meeting held January 17, 1882, several amendments to the Constitution, proposed by a committee appointed for the purpose, were considered by the Society and adopted. The following is the present Constitution as amended at that meeting :

AMENDED CONSTITUTION.

ARTICLE I.—*Name.*

The name of this Society shall be "THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON."

ARTICLE II.—*Object.*

The object of this Society shall be to encourage the study of the Natural History of Man, especially with reference to America, and shall include Somatology, Sociology, Philology, Philosophy, Psychology, and Technology.

ARTICLE III.—*Members.*

The members of this Society shall be persons who are interested in Anthropology, and shall be divided into three classes: Active, Corresponding, and Honorary. The active members shall be those who reside in Washington, or in its vicinity, and who shall pay the dues required by Article XV. Failure to comply with this provision within two months after notice of election, unless satisfactorily explained to the Council, shall render the election void. Corresponding members shall be those who are engaged in anthropological investigations in other localities; honorary members shall be those who have contributed by authorship or patronage to the advancement of Anthropology. Corresponding or honorary members may become active members by paying the fee required by Article XV.

All members shall be elected by the Council and by ballot, as follows: The name of the candidate shall be recommended to the Council, in writing, by two members of the Society, and eight affirmative ballots shall be necessary to an election.

No person shall be entitled to the privileges of active membership before paying the admission fee provided in Article XV.

ARTICLE IV.—*Officers.*

The officers of this Society shall be a President, four Vice Presidents, a General Secretary, a Secretary to the Council, a Treasurer, and a Curator, all of whom, together with six other active members, shall constitute a Council, all to be elected by ballot at each annual

meeting. The officers shall serve one year, or until their successors are elected.

ARTICLE V.—*The Council.*

All business of the Society, except the election of officers at the annual meeting, shall be transacted by the Council, five members of which shall constitute a quorum.

The Council shall meet one half-hour before the regular sessions of the Society, and at such other times as they may be called together by the President. They may call special meetings of the Society.

ARTICLE VI.—*The Sections.*

For active operations the Society shall be divided into four sections, as follows: Section A, Somatology; Section B, Sociology; Section C, Philology, Philosophy, and Psychology; Section D, Technology. The Vice-Presidents of the Society shall be *ex officio* chairmen of these sections respectively, and shall be designated by the President to their sections after their election. It shall be the duty of these sections to keep the Society informed upon the progress of research in their respective fields, to make special investigations when requested by the Council, to announce interesting discoveries, to collect specimens, manuscripts, publications, newspaper clippings, etc., and in every way to foster their divisions of the work.

All papers presented to the sections shall be referred to the Council, and through it to the Society.

ARTICLE VII.—*The President.*

The President, or, in his absence, one of the Vice-Presidents, shall preside over the meetings of the Society and of the Council, and shall appoint all committees in the Council and in the Society. At the first meeting in February the retiring President shall deliver an address to the Society.

ARTICLE VIII.—*The Vice-Presidents.*

The Vice-Presidents shall respectively preside over the sections to which they have been designated, and represent such sections in the Council and in the Society.

Each of the Vice-Presidents shall deliver an address during the year upon such subject within his department as he may select.

ARTICLE IX.—*The General Secretary.*

It shall be the duty of the General Secretary to record the transactions and conduct the general correspondence of the Society.

ARTICLE X.—*The Secretary to the Council.*

The Secretary to the Council shall keep the minutes of the Council, shall keep a list of active, corresponding, and honorary members, with their residences, shall notify members of the time and place of all meetings of the Society, and shall perform such other duties as the Council may direct.

ARTICLE XI.—*The Treasurer.*

The Treasurer shall receive and have charge of all moneys; he shall deposit the funds as directed by the Council, and shall not expend any money except as ordered by the Council. He shall notify members in writing when their dues have remained unpaid for six months.

ARTICLE XII.—*The Curator.*

The Curator shall receive, acknowledge, and have charge of all books, pamphlets, photographs, clippings, and other anthropological material, and shall dispose of them in accordance with Article XVI, keeping a record of them in a book provided by the Society.

ARTICLE XIII.—*Meetings.*

The regular meetings of the Society shall be held on the first and the third Tuesday of each month from November to May, inclusive. An annual meeting for the election of officers shall be held on the third Tuesday of January in each year, a quorum to consist of twenty active members who are not in arrears for dues; and visitors shall not be admitted. The proceedings of the Society shall be conducted in accordance with the established rules of parliamentary practice. Papers read shall be limited to twenty minutes, after which the subject shall be thrown open for discussion, remarks thereon to be limited to five minutes for each speaker.

ARTICLE XIV.—*Publications.*

The address of the President, provided in Article VII, and the transactions of the Society, shall be printed and published annually, or at such periods and in such form as may be determined by the Council.

ARTICLE XV.—*Fees and Dues.*

The admission fee to be paid by members elect shall be five dollars, and the annual dues, to be paid on the first of January, shall be three dollars. The names of members failing to pay their dues one month after written notice from the Treasurer, as provided in Article XI, shall be dropped from the roll, unless from absence of the member from Washington or other satisfactory explanation, the Council shall otherwise determine.

ARTICLE XVI.—*Gifts.*

It shall be the duty of all members to seek to increase and perfect the materials of anthropological study in the national collections at Washington. All gifts of specimens, books, pamphlets, maps, photographs, and newspaper clippings, shall be received by the Curator, who shall exhibit them before the Society at the next regular meeting after their reception, and shall make such abstract or entry concerning them in a book provided by the Society, as will secure their value as materials of research; after which all archæological and ethnological materials shall be deposited in the National Museum, in the name of the donor and of the Society; all crania and somatic specimens, in the Army Medical Museum; all books, pamphlets, photographs, clippings, and abstracts, in the archives of the Society.

ARTICLE XVII.—*Amendments.*

This constitution shall not be amended except by a three-fourths vote of the active members present at the annual meeting for the election of officers, and after notice of the proposed change shall have been given in writing at a regular meeting of the Society, at least one month previously.

ARTICLE XVIII.—*Order of Business.*

The order of business at each regular meeting shall be:

1. Reading the minutes of the last meeting.
2. Report of the Council upon membership.
3. Report of the Curator.
4. Reading of papers and discussions.
5. Notes and queries.

LIST OF MEMBERS

OF THE

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

Corrected to September 18, 1882.

The following list aims simply to facilitate correspondence with the members of the Society. It therefore only gives the post-office address of each member, and the particular form and style in which he prefers to be addressed. So few members known to have university degrees having expressed a desire to have them printed in the list of members, and some having objected to this being done, it was thought best to omit them in all cases. Washington, D. C., is understood unless otherwise specified.

ACTIVE MEMBERS.

Dr. THOMAS ANTISELL, 1311 Q street N. W.
Dr. A. T. AUGUSTA, 1319 L street N. W.
Dr. FRANK BAKER, 366 C street N. W.
Mr. HENRY M. BAKER, 1411 F street N. W.
Dr. EMIL BESSELS, 1441 Massachusetts Avenue N. W.
Mr. OTIS BIGELOW, 605 Seventh street N. W.
Dr. J. F. BRANSFORD, U. S. Navy.
Mr. J. STANLEY BROWN, 1318 Massachusetts Avenue N. W.
Hon. HORATIO C. BURCHARD, U. S. Treasury Department.
Mr. EDSON A. BURDICK, U. S. Pension Office.
Dr. SWAN M. BURNETT, 1215 I street N. W.
Prof. J. W. CHICKERING, Jr., National Deaf-Mute College.
Mr. FRANK H. CUSHING, Zúñi, New Mexico.
Rev. J. OWEN DORSEY, Bureau of Ethnology, Box 585.
Mr. CHAS. L. DUBOIS, 605 Seventh street N. W.

- Capt. C. E. DUTTON, U. S. A., Geological Survey, Box 591.
Mr. THEO. F. DWIGHT, Department of State.
Prof. EDWARD ALLEN FAY, National Deaf-Mute College.
Dr. ROBERT FLETCHER, 1326 L street N. W.
Mr. WESTON FLINT, Librarian U. S. Patent Office.
Prof. E. T. FRISTOE, Columbian University.
Dr. E. M. GALLAUDET, President National Deaf-Mute College.
Mr. HENRY GANNETT, 1881 Harewood Avenue, LeDroit Park.
Mr. ALBERT S. GATSCHET, Bureau of Ethnology, Box 591.
Mr. C. D. GEDNEY, U. S. Coast Survey Office.
Mr. G. K. GILBERT, U. S. Geological Survey, Box 591.
Mr. H. P. GODWIN, "Star" Office.
Mr. G. BROWN GOODE, Smithsonian Institution.
Prof. J. HOWARD GORE, 1305 Q street N. W.
Dr. CHAS. E. HAGNER, 1400 H street N. W.
Dr. WM. H. HAWKES, U. S. A., Army Dispensary, 1733 G street N. W.
Mr. H. W. HENSHAW, Bureau of Ethnology, Box 591.
Mr. S. D. HINMAN, Bureau of Ethnology, Box 591.
Dr. W. J. HOFFMAN, Bureau of Ethnology, Box 591.
Mr. WM. H. HOLMES, 18 Vernon Row.
Dr. FRANKLIN B. HOUGH, Chief Forestry Div., Dept. of Agriculture.
Mr. M. B. W. HOUGH, 312 Indiana Avenue N. W.
Dr. D. L. HUNTINGTON, U. S. A., Army Medical Museum.
Mr. DAVID HUTCHESON, Library of Congress.
Mr. ERNEST INGERSOLL, New York City.
Mr. JOHN IRWIN, Jr., U. S. Geological Survey, Box 585.
Dr. JOS. TABER JOHNSON, 937 New York Avenue N. W.
Mr. GEORGE KENNAN, Lock box 23.
Dr. A. F. A. KING, 726 Thirteenth street N. W.
Dr. WILLIAM LEE, 2111 Pennsylvania Avenue.
Mr. DANIEL LEECH, Smithsonian Institution.
Mr. JOSEPH LIBBEY, 3043 West street, Georgetown.
Capt. E. P. LULL, U. S. N., Navy Department.
Judge ARTHUR MACARTHUR, 1201 N street N. W.
Rev. CLAY MACCAULEY, 43 Linwood street, Roxbury, Massachusetts.
Mr. HENRY B. F. MACFARLAND, 1727 F street N. W.
Col. GARRICK MALLERY, U. S. A., Bureau of Ethnology, Box 591.
Prof. OTIS T. MASON, 1305 Q street N. W.
Mr. J. D. MCGUIRE, Ellicott City, Maryland.

- Prof. A. P. MONTAGUE, Columbian University.
Dr. JAMES E. MORGAN, 905 E street N. W.
Dr. P. J. MURPHY, Columbia Hospital.
Mr. E. W. NELSON, Colorado Springs, Col.
Mr. J. A. NORRIS, 1236 Thirteenth street N. W.
Mr. P. W. NORRIS, Bureau of Ethnology, Box 585.
Mr. IVAN PETROFF, U. S. Census Office.
Mr. J. C. PILLING, Bureau of Ethnology, Box 585.
Prof. SAMUEL PORTER, National Deaf-Mute College.
Major J. W. POWELL, Box 585.
Dr. D. WEBSTER PRENTISS, 1224 Ninth street N. W.
Mr. S. V. PROUDFIT, U. S. Pension Office.
Lieut. W. W. REISINGER, U. S. N., 1209 Thirteenth street N. W.
Dr. ELMER R. REYNOLDS, U. S. Pension Office.
Mr. WM. J. RHEES, Smithsonian Institution.
Prof. C. V. RILEY, 1700 Thirteenth street N. W.
Mr. LOUIS W. RITCHIE, 3259 N street N. W., (Georgetown.)
Dr. MILES ROCK, 1430 Chapin street.
Mr. C. C. ROYCE, 607 I street N. W.
Mr. NEWTON P. SCUDDER, Smithsonian Institution.
Col. F. A. SEELY, U. S. Patent Office.
Dr. R. W. SHUFELDT, U. S. A., care Surgeon General.
Mr. C. W. SMILEY, Smithsonian Institution.
Mr. JOHN D. SMITH, U. S. Pension Office.
Dr. Z. T. SOWERS, 1324 New York Avenue.
Gen. ELLIS SPEAR, Lock box 1.
Dr. J. O. STANTON, 1344 G street N. W.
Mr. JAMES STEVENSON, Box 585.
Mr. BENJAMIN SWALLOW, Washington, D. C.
Prof. CYRUS THOMAS, 1246 Eleventh street N. W.
Mr. HENRY L. THOMAS, Department of State.
Dr. J. FORD THOMPSON, 1000 Ninth street N. W.
Dr. J. M. TONER, 615 Louisiana Avenue.
Mr. FREDERICK W. TRUE, Smithsonian Institution.
Mr. E. P. VINING, Gen. Freight Dept., U. P. R. R., Omaha, Neb.
Mr. LESTER F. WARD, U. S. Geological Survey, Box 585.
Dr. JAMES C. WELLING, President Columbian University.
Dr. H. C. YARROW, 814 Seventeenth street N. W.

CORRESPONDING MEMBERS.

- Mr. A. F. BERLIN, Allentown, Pa.
Mr. DRAKE CARTER, Versailles, Ky.
Mr. G. C. COMFORT, Syracuse, N. Y.
Mr. FRANK COWEN, Greensburg, Pa.
Dr. R. J. FARQUHARSON, Des Moines, Iowa.
Major A. M. HANCOCK, Churchville, Md.
Rev. HORACE EDWIN HAYDEN, Wilkes Barre, Pa.
Dr. P. R. HOY, Racine, Wis.
Hon. J. WARREN KEIFER, Springfield, Ohio.
Dr. OSCAR LOEW, Botanical Institute, Karl Strasse 29, Munich, Germany.
Dr. JOHN G. MORRIS, Baltimore, Md.
Mr. B. B. REDDING, 2100 California street, San Francisco, Cal.
Mr. J. H. RIVETT-CARNAC, Allahabad, India.
Rev. EDMUND F. SLAFTER, Boston, Mass.
Mr. W. C. WHITFORD, Milton, Wis.
Prof. ALEXANDER WINCHELL, Ann Arbor, Mich.

HONORARY MEMBERS.

- Prof. SPENCER F. BAIRD, Secretary Smithsonian Institution.
Dr. WASHINGTON MATTHEWS, U. S. A., Fort Wingate, New Mexico.

TRANSACTIONS.

FIRST REGULAR MEETING, March 4, 1879.

Mr. Frank H. Cushing read a paper entitled RELIC HUNTING.¹

Mr. P. W. Norris read a paper entitled SOME MODES OF INDIAN BURIAL.²

SECOND REGULAR MEETING, March 18, 1879.

Mr. G. K. Gilbert read a paper entitled SOME INDIAN PICTOGRAPHS.²

Prof. Otis T. Mason made some OBSERVATIONS ON AZTEC AND GUATEMALAN ANTIQUITIES.³

THIRD REGULAR MEETING, April 1, 1879.

Mr. Frank H. Cushing read a paper entitled ARROW-HEAD MAKING.⁴

Mr. G. K. Gilbert concluded his paper on INDIAN PICTOGRAPHS.²

FOURTH REGULAR MEETING, April 16, 1879.

Dr. Swan M. Burnett read a paper entitled COLOR-BLINDNESS AS AFFECTED BY RACE.⁵

¹"Abstract of Transactions of the Anthropological Society of Washington, D. C., with the Annual Address of the President, for the First Year ending January 20, 1880, and for the Second Year ending January 18, 1881. Prepared by J. W. Powell." Washington, 1881. P. 3.

²*Loc. cit.*, p. 4.

³*Loc. cit.*, p. 6.

⁴*Loc. cit.*, p. 7.

⁵*Loc. cit.* p. 7: Cf. "Color-Blindness" in "National Medical Review," April, 1879, vol. I, pp. 191-198; also "Results of an examination of the Color-Sense of 3,040 children in the public schools of the District of Columbia," in "Archives of Ophthalmology," New York, vol. VIII, pp. 191-199; also reprint. Translated into the "Archiv für Augenheilkunde" Bd. IX, S. 146-148, and Separat-Abdruck.

FIFTH REGULAR MEETING, May 5, 1879.

Mr. Wills De Hass read a paper entitled PROGRESS OF ARCHÆOLOGIC RESEARCH IN THE UNITED STATES.¹

Prof. J. Howard Gore read a paper entitled THE OLD ROMAN SENATE; A STUDY OF DELIBERATIVE ASSEMBLIES.¹

Mr. Albert S. Gatschet read a paper entitled INDIAN COLOR NAMES.²

SIXTH REGULAR MEETING, May 20, 1879.

Dr. Miles Rock read a paper entitled INDIAN PICTOGRAPHS IN NEW MEXICO.³

Dr. Elmer R. Reynolds read a paper describing an ABORIGINAL PAINT QUARRY.⁴

The Secretary read a paper by Mr. Victor Harvard entitled FRENCH AND INDIAN HALF-BREEDS OF THE NORTHWEST.⁵

SEVENTH REGULAR MEETING, June 3, 1879.

Col. Garrick Mallery read a paper entitled COMPARATIVE MYTHOLOGY OF THE TWO INDIES.⁵

Dr. Elmer R. Reynolds read a paper entitled ABORIGINAL CEMETERIES NEAR PISCATAWAY, MD.⁶

EIGHTH REGULAR MEETING, June 17, 1879.

Prof. Theodore Gill, by invitation, read a paper ON THE ZOÖLOGICAL RELATIONS OF MAN.⁷

NINTH REGULAR MEETING, October 7, 1879.

Col. Garrick Mallery gave an account of the proceedings of the Anthropological Section of the American Association for the Advancement of Science at its meeting held at Saratoga, New York.

¹ *Loc. cit.*, p. 9.

² *Loc. cit.*, p. 10; Also: "Adjectives of Color in Indian Languages," in "American Naturalist," vol. XIII, pp. 475-485.

³ *Loc. cit.*, p. 10.

⁴ *Loc. cit.*, p. 11.

⁵ *Loc. cit.*, p. 12.

⁶ *Loc. cit.*, p. 14.

⁷ *Loc. cit.*, p. 15.

Prof. Otis T. Mason made some remarks upon the preservation of ancient monuments.¹ •

TENTH REGULAR MEETING, October 21, 1879.

Col. Garrick Mallery read a paper entitled THE SIGN LANGUAGE OF THE NORTH AMERICAN INDIANS.²

ELEVENTH REGULAR MEETING, November 4, 1879.

Dr. W. J. Hoffman read a paper entitled POISONED WEAPONS OF NORTH AND SOUTH AMERICA.³

Mr. G. Brown Goode read a paper entitled THE USE OF AGRICULTURAL FERTILIZERS BY THE AMERICAN INDIANS AND THE EARLY ENGLISH COLONISTS.⁴

TWELFTH REGULAR MEETING, November 18, 1879.

Prof. Otis T. Mason read a paper entitled A COMPARISON OF A WRITTEN LANGUAGE WITH ONE THAT IS SPOKEN ONLY.⁵

Dr. Elmer R. Reynolds read a paper ON THE ABORIGINAL SHELL-HEAPS AT POPE'S CREEK, MARYLAND.⁶

THIRTEENTH REGULAR MEETING, December 2, 1879.

Mr. John C. Lang read a paper entitled ANCIENT MAPS OF NORTH AMERICA.⁷

¹ *Loc. cit.*, p. 17.

² *Loc. cit.*, p. 19: Cf. "The Gesture Speech of Man," address by Col. Garrick Mallery, Chairman of Subsection of Anthropology of the A. A. A. S.; "Proceedings," vol. XXX, pp. 283-313; also "Sign Language among North American Indians compared with that among other Peoples and Deaf-Mutes," in "Annual Report of the Bureau of Ethnology," 1879-'80, pp. 269-552.

³ *Loc. cit.*, p. 21.

⁴ "American Naturalist," vol. XIV, pp. 473-479.

⁵ "Abstract of Transactions, &c.," p. 21; also "Bulletin Philosophical Society of Washington," vol. III, pp. 139-140.

⁶ *Loc. cit.*, p. 23.

⁷ *Loc. cit.*, p. 25.

Dr. Miles Rock read a paper ON THE EFFACING POWER OF TROPICAL FOREST GROWTH IN TRINIDAD ISLAND.¹

Capt. Edward P. Lull, U. S. N., read a paper ON THE DETERMINATION OF THE AGE OF PREHISTORIC REMAINS.²

Prof. C. V. Riley read a letter from a correspondent, Mr. H. P. Bee, in San Antonio, Texas, relating to the discovery of a remarkable cave in a mountain standing in the valley of the Rio Nazas, State of Durango, Mexico.³

FOURTEENTH REGULAR MEETING, December 16, 1879.

President Powell related the folk-story of the "Tar Baby" and the Indian story of the "Three Cranberries."⁴

Dr. Elmer R. Reynolds read a paper entitled TURTLE-BACK CELTS AND THEIR USES.⁴

FIFTEENTH REGULAR MEETING, January 6, 1880.

Mr. J. D. McGuire read a paper entitled SHELL-HEAPS OF SOUTH RIVER, MARYLAND.⁵

SIXTEENTH REGULAR AND SECOND ANNUAL MEETING, January 20, 1880.

The annual election of officers took place, with the following result:

PRESIDENT	J. W. POWELL.
VICE-PRESIDENTS	{ J. M. TONER. GEORGE A. OTIS. GARRICK MALLERY. WILLS DEHASS.
CORRESPONDING SECRETARY	OTIS T. MASON.
RECORDING SECRETARY	ELMER R. REYNOLDS.
TREASURER	JOHN C. LANG.
CURATOR	FRANK H. CUSHING.
COUNCIL AT LARGE	{ E. M. GALIAUDET. H. C. VARROW. C. A. WHITE. G. K. GILBERT. J. M. WILSON. ELLIOTT COUES.

¹ *Loc. cit.*, p. 26.

² *Loc. cit.*, p. 27.

³ *Loc. cit.*, p. 29; cf. "Bull. No. 3, U. S. Entomological Commission," p. 132.

⁴ *Loc. cit.*, p. 30.

⁵ *Loc. cit.*, p. 31.

Commander W. Bainbridge Hoff, U. S. N., read a paper entitled
A STRANGE CHART.¹

SEVENTEENTH REGULAR MEETING, February 3, 1880.

Dr. Wills DeHass read a paper entitled THE MOUND-BUILDERS:
AN INQUIRY INTO THEIR ASSUMED SOUTHERN ORIGIN.²

EIGHTEENTH REGULAR MEETING, February 17, 1880.

Dr. H. C. Yarrow read a paper entitled BURIAL CUSTOMS OF
THE NORTH AMERICAN INDIANS.³

Prof. J. Howard Gore read a paper entitled THE DEVELOPMENT
OF DELIBERATIVE GOVERNMENT AMONG THE NORTH AMERICAN
INDIANS.⁴

NINETEENTH REGULAR MEETING, March 2, 1880.

The President, Major J. W. Powell, delivered his Annual Address,
the subject being THE EVOLUTION OF LANGUAGE, AS EXHIBITED
IN THE SPECIALIZATION OF THE GRAMMATIC PROCESSES, THE DIF-
FERENTIATION OF THE PARTS OF SPEECH, AND THE INTEGRATION
OF THE SENTENCE; FROM A STUDY OF INDIAN LANGUAGES.⁵

¹ *Loc. cit.*, p. 33; also in "The Evening Star," Washington, D. C.; Jan. 24, 1880, p. 2.

² *Loc. cit.*, p. 55.

³ "Introduction to the Study of Mortuary Customs among the North American Indians, by Dr. H. C. Yarrow, Act. Asst. Surg. U. S. A., published by the Bureau of Ethnology, Washington, 1880. Cf. "A Further Contribution to the Study of the Mortuary Customs of the North American Indians," by the same author, in "Annual Report of the Bureau of Ethnology," 1879-'80, pp. 87-203.

⁴ *Loc. cit.*, p. 58.

⁵ *Loc. cit.*, p. 35. Cf. "Introduction to the Study of Indian Languages," 2d edition, Washington, 1880, by J. W. Powell, Director of the Bureau of Ethnology, Chapter II; also "Annual Report of the Bureau of Ethnology," 1879-'80, pp. 1-16.

TWENTIETH REGULAR MEETING, March 16, 1880.

Mr. Albert S. Gatschet read a paper entitled THE FOUR CREATIONS OF MANKIND—A TUALATI MYTH.¹

TWENTY-FIRST REGULAR MEETING, April 6, 1880.

Mr. C. C. Royce read a paper on THE INDIAN TITLE—THE METHOD AND CHRONOLOGY OF ITS EXTINGUISHMENT BY THE UNITED STATES.²

TWENTY-SECOND REGULAR MEETING, April 20, 1880.

Mr. Lester F. Ward read a paper entitled PRE-SOCIAL MAN.³

TWENTY-THIRD REGULAR MEETING, May 4, 1880.

Mr. A. L. Guss read a paper entitled WHO WERE THE MASSA-WOMEKES?⁴

TWENTY-FOURTH REGULAR MEETING May 18, 1880.

Dr. Elmer R. Reynolds read a paper on THE DUNBARTON ABORIGINAL SOAPSTONE QUARRY.⁵

Prof. E. A. Fay read a paper entitled THE TESTIMONY OF THE ROMANCE LANGUAGES CONCERNING THE FORMS OF THE IMPERFECT AND PLUPERFECT SUBJUNCTIVE IN THE ROMAN FOLK-SPEECH.⁶

¹ *Loc. cit.*, p. 60.

² *Loc. cit.*, p. 64: also "Cessions of Land by Indian Tribes to the United States: illustrated by those in the State of Indiana," by C. C. Royce, in "Annual Report of the Bureau of Ethnology," 1879-'80, pp. 247-262, with map.

³ *Loc. cit.*, p. 68. This paper is condensed from Chapter VI (vol I, pp. 424-446), of the author's forthcoming work, "Dynamic Sociology, &c.," in press, D. Appleton & Co., New York.

⁴ *Loc. cit.*, p. 71.

⁵ "Twelfth annual Report of the Peabody Museum of Archaeology and Ethnology," Cambridge, 1879, pp. 526-535; also reprint.

⁶ "Abstract of Transactions," &c., p. 72: also in full in "The American Journal of Philology," vol. I, pp. 410-415.

TWENTY-FIFTH REGULAR MEETING, June 1, 1880.

Prof. Samuel Porter read a paper entitled IS THOUGHT POSSIBLE WITHOUT LANGUAGE?—CASE OF A DEAF-MUTE.¹

TWENTY-SIXTH REGULAR MEETING, June 15, 1880.

Major J. W. Powell, President of the Society, read a paper entitled WYANDOT GOVERNMENT—A SHORT STUDY OF TRIBAL SOCIETY.²

TWENTY-SEVENTH REGULAR MEETING, October 5, 1880.

Col. Garrick Mallery read a paper entitled SCHEME OF THE TENTH CENSUS FOR THE ENUMERATION OF UNTAXED INDIANS.³

Dr. Elmer R. Reynolds gave an account of an OSSUARY AT ACCOTINK, VIRGINIA.³

TWENTY-EIGHTH REGULAR MEETING, October 19, 1880.

Mr. C. C. Royce read a paper entitled AN INQUIRY INTO THE HISTORY AND IDENTITY OF THE SHAWNEE INDIANS.⁴

Mr. M. B. W. Hough read a paper entitled CIVILIZATION.⁵

No quorum was present on November 2, 1880, and therefore no meeting was held.

TWENTY-NINTH REGULAR MEETING, November 16, 1880.

Prof. J. Howard Gore read a paper entitled TUCKAHOE OR INDIAN BREAD.⁶

¹ *Loc. cit.*, p. 74; also in full in "Princeton Review," Jan. 1881, pp. 104-123.

² *Loc. cit.*, p. 76; also in "Annual Report of the Bureau of Ethnology," 1879-'80, pp. 57-69.

³ *Loc. cit.*, p. 92.

⁴ *Loc. cit.*, p. 94.

⁵ *Loc. cit.*, p. 100.

⁶ *Loc. cit.*, p. 101. To be published in full in the "Smithsonian Report" for 1881.

Dr. Elmer R. Reynolds read a paper entitled **INDIAN MOUNDS IN THE SHENANDOAH VALLEY**.¹

THIRTIETH REGULAR MEETING, December 7, 1880.

Mr. Albert S. Gatschet read a paper entitled **SUPERSTITIONS**.¹

THIRTY-FIRST REGULAR MEETING, December 21, 1880.

Mr. Lester F. Ward read a paper entitled **SAVAGE AND CIVILIZED ORTHOEPEY**.²

No quorum was present on January 4, 1881, and the meeting was postponed.

THIRTY-SECOND REGULAR AND THIRD ANNUAL MEETING,
January 18, 1881.

The annual election of officers was held. The following officers were elected :

PRESIDENT	. . . . .	J. W. POWELL.
VICE PRESIDENTS	. . . . .	{ GARRICK MALLERY. OTIS T. MASON. H. C. YARROW. GEORGE A. OTIS.
CORRESPONDING SECRETARY	. . . . .	C. C. ROYCE.
RECORDING SECRETARY	. . . . .	LESTER F. WARD.
TREASURER	. . . . .	J. HOWARD GORE.
CURATOR	. . . . .	W. J. HOFFMAN.
COUNCIL	. . . . .	{ J. C. WELLING. F. A. SEELY. MILES ROCK. H. L. THOMAS. J. M. TONER. EDWARD ALLEN FAY.

¹ *Loc. cit.*, p. 103.

² *Loc. cit.*, p. 106.

THIRTY-THIRD REGULAR MEETING, February 1, 1881.

The President, Major J. W. Powell, delivered his annual address
ON LIMITATIONS TO THE USE OF SOME ANTHROPOLOGIC DATA.¹

THIRTY-FOURTH REGULAR MEETING, February 15, 1881.

Mr. Henry L. Thomas read a paper ON SOME PECULIARITIES
IN THE USE OF MOODS IN THE PRINCIPAL NEO-LATIN LANGUAGES.

The following is an abstract:

The object of the paper was to illustrate various points of comparison existing in the use of the moods in the principal Neo-Latin languages. Mr. Thomas referred, in the first place, to the meagre degree of attention which has been given to the subject of the accurate use of the moods by the Italian grammarians, and the devotion with which almost all of them continue to regard the usage of Boccaccio and the writers of that period. He next called attention to the service rendered to the Italian language of the present day by Giuseppe Rigutini, a citizen of Florence, who has done much for the promotion of stylistic purity by the publication of his Vocabulary of the Spoken Language, a work which marks an epoch in Italian lexicography, inasmuch as the author, boldly striking out into a new path, has had the courage to disregard the usage of Petrarch and Boccaccio, and to accord a scientific treatment to the language of to-day.

Many examples were adduced with a view to presenting a kind of parallel view of the use of the moods (principally the subjunctive) in French, Italian, Spanish, and Portuguese. A few examples of the use of the French subjunctive, as exhibited in writings a little more than two hundred years old, were given to show that this mood was then used (or that its use was at least allowable) in connection with verbs of thinking and believing, in affirmative sentences, and the fact was adverted to that that practice no longer

¹ *Loc. cit.*, pp. 113-136; also in "Annual Report of the Bureau of Ethnology," 1879-'80, pp. 71-86.

prevails in any of the languages under consideration, with the exception of Italian.

Reference was incidentally made to deviations by classic writers and reputable modern Latinists from the rule that "dependent clauses, containing an indirect question, take the subjunctive." It was shown that, while such deviations were frequent in Plautus and Terence, they were of by no means rare occurrence in the writings of many Latin poets, of Seneca, and even of Cicero, although, in the instances in which the last-named writer deviates from this rule, modern editors have made him conform to it.

Attention was called, in conclusion, to certain points connected with the use of the tenses of the Portuguese subjunctive, in reference to which modern grammarians continue to advocate a usage which is really, at the present day, practically obsolete.

The paper was discussed by Prof. Fay, Dr. Antisell, Dr. Welling, Mr. Ward, and Prof. Mason.

Prof. Fay expressed his gratification at listening to so learned a production, and regarded it as confirmatory of the views he had previously presented to the Society.¹

He regretted that it was not possible to systematize the data in more exact chronological order.

Dr. Antisell remarked upon the tendency of languages to dispense more and more with the subjunctive mood as to a great extent a useless appendage.

Dr. Welling also noted the progress made in sloughing off redundant forms, and thought it quite possible that this process might go too far. He said that there was a very perceptible difference in the meaning conveyed by the English subjunctive and indicative, which it would be a pity to lose the power of expressing.

Mr. Ward was interested in the cases adduced in Latin of the dependent interrogative with the indicative, which appears to be chiefly used in colloquialisms, showing that the common people were disposed to eliminate unnecessary grammatical formalities.

¹ See p. 26, *supra*.

He also alluded to the complicated character of savage and barbaric languages, and regarded this tendency towards simplification as constituting a true progress towards practical economy in speech.

Dr. Elmer R. Reynolds read a paper giving a description of an ABORIGINAL BURIAL-CAVE IN THE VALLEY OF THE SOUTH SHEN-ANDOAH.

The cave in question is situated in Limestone Hill, an eastern spur of the Massanutton Mountain, nine miles northwest of Luray, Va. The hill lies on the southern bank of the river, from which it is separated by a narrow valley a few hundred yards wide. An old village lies about a fourth of a mile west of the cave, and nearer by is, or rather was, an extensive cemetery. The entrance to the cave itself is situated about forty feet above the valley, on a steep and thickly wooded hillside. The opening is oblong, six feet east and west by two feet north and south. The descent is vertical for six feet, and from thence slopes very steeply down in a south-westerly direction. This room, or passage, is about twenty-five feet long by twelve or fifteen feet high; the floor is covered with large boulders and slabs of limestone intermixed with human bones and *débris* washed down from the hillside above the opening.

Leading from this chamber is a passage seventeen feet in length by fourteen inches in height and twelve inches in width. This passage, or gallery, ends in a room ten feet long, eight feet high, and from four to six feet wide. Beyond this chamber and approached through a narrow opening is a third chamber from four to six feet high, six feet long, and four feet wide, the length being transverse to the others. Another passage leads from this by two openings, one extending in a westerly direction on a line with the floor and the second situated about four feet above and partially closed by depending stalactites. This superior passage slopes downward, and joins the lower opening about three feet from the floor. The smaller of these stalactites was broken away, and an ineffectual effort made to force a passage beyond. The largest stalactite at this opening was from seven inches to a foot in diameter and about three feet long.

The floors in all the chambers and passages were composed of travertine with a soft tufaceous deposit above. The floors average from three-fourths of an inch to two or three inches in thickness, and, under ordinary circumstances, would require a considerable period of time in their formation.

Upon breaking through these floors with a pick-axe—which was not accomplished without some difficulty owing to the hardness of the material—a solid compact mass of ashes, coal, and sand, and a profusion of human bones were found. Only a few animal bones were found; among these were the bones of the squirrel and turtle. Several very finely preserved crania were also found firmly attached to the side of the third chamber below the floor. Only one of these was dislodged without injury, the others being thickly covered with tufa.

Two or three shafts were sunk down to a depth of about three feet. Human bones and ashes were found at all depths.

Both chambers (Nos. 3 and 4, not including the entrance, or long passage) were alike in character below the floor.

Notwithstanding the presence of charcoal and ashes, none of the bones showed any traces of cremation. The speaker felt confident, however, that upon cleaning out this cavern to a depth of ten feet, he would find abundant proof that this system of burial had been practiced at this place, although the process may have been, and probably was, carried on outside of the cave previous to final sepulture. He based this hypothesis upon the fact of finding unquestionable evidences of cremation in both primary and secondary burial mounds and ossuaries in the same valley.

This cave was examined with the assistance of Mr. Benton P. Stebbins, of Luray; Dr. Logan, of Cedar Point; Mr. Joseph Keyser, on whose estate the cave is situated, and also by Messrs. William Oothout and Joseph Williamson, both of whom are attached to the Bellevue Hospital Medical College of New York City. These gentlemen came on from the east expressly to assist the speaker in his aboriginal research in the Shenandoah Valley.

To Messrs. Oothout and Williamson the speaker was deeply indebted for sketches, diagrams, and measurements of the mounds and other aboriginal remains subsequently explored by the party.

With reference to the age of the burial cave, as a place of sepulture, the explorer cautiously reserved his opinion until he should again visit the locality and complete his research by removing all the *débris* in the bottom to a depth of two or three yards. The present floor, he thought, is now near the former roof of the cave.

Some of the stalagmites on the floor of the second chamber were four inches in diameter at the base and nearly a foot high; yet this feature could not safely be taken as an indication of the time since the cave had ceased to be used for burial purposes, as the free humidity of the overlying soil—or an absence of the same condition—would have a direct tendency very greatly to accelerate or retard the formation of both travertine and stalagmites.

THIRTY-FIFTH REGULAR MEETING, March 1, 1881.

Mr. Ivan Petroff read a paper entitled AMPHIBIOUS ABORIGINES OF ALASKA.

He described a peculiar tribe of Innuits who inhabit the lower Kuskoquim and the coast from Cape Newenham nearly to Bristol Bay, in Alaska, and who spend at least half of their time on or in the water. Their houses are built close to the sea-shore, and they spend a large part of their time in their skin-boats or “kiaks.” The children go nearly naked, and are as much at home in their kiaks as on land. The people live chiefly on fish and seals, which they spear with great skill. They keep their weapons and boats scrupulously clean, this being essential to success in hunting, but pay no attention to the cleansing of their own bodies which are allowed to become extremely filthy. They eat their food for the most part uncooked. Storms and tides often inundate the swampy shore on which their partly subterranean dwellings are built, and

filling them with water, drive the inmates out to take refuge on the roof, where whole families are often huddled together for hours or even days. In making long journeys to remote fishing-grounds the father takes the young children in the kiak and the women follow the low swampy shore on foot, often wading waist deep across estuaries or through marshes. If a storm rages in the night the kiak is turned on its side and the family sleep with their heads alone protected under it and the remainder of their bodies stretched out upon the ground.

The private dwellings are dark so that that they cannot work in them, but they construct large council-houses, or kashimas, lighted by a spacious opening in the roof, and where they assemble and make their weapons and canoes, and work at curious carvings in ivory. Here also the young men gather to listen to the adventures of their elders, and be trained in the pursuits of life. They purposely inure themselves to hardships, such as sitting upright for entire nights to fit them for long watches in their kiaks at sea, and in this process of education the old men are very severe task-masters. The young man is emancipated from all family connection as soon as he is able to build himself a kiak. He then ceases to be a permanent resident of his village, and roams about as fancy dictates. On the banks of the Togiak the writer had found whole communities, men, women, and children, moving from place to place from May until October or November, without house or shelter except the upturned kiak. One of these serves a whole family; and there are times when as many as four or five hundred such temporary shelters can be seen on bars and along the low banks of the stream where fish and game abound. They present a striking appearance when the members of a family crowd their heads into the circular opening of the kiak with their feet and bodies protruding and exposed to the rain. "Surely," remarked the speaker, "many species of animals employ greater sagacity and energy in providing shelter for themselves and offspring."

These people drink a great deal of water without regard to

quality, taking it often from stagnant pools or ponds, where fish are cleaned and offal is thrown in. In their excursions out to sea they never take supplies of fresh water, but drink sea water. These practices have no apparent effect on their health. They never bathe or wash their bodies, but on certain occasions the men light a fire in the kashima, strip themselves and dance and jump around until in a profuse perspiration. They then apply urine to their oily bodies and rub them until a lather appears, after which they plunge into the river. The sports of children are all aquatic, such as sailing miniature canoes or pieces of drift wood, building fish-traps, throwing spears and arrows at gulls and other birds, and then wading or plunging in to recover them. In winter these people huddle together in their little quarters where they have no form of artificial heat except what is furnished by smoking and flaring oil lamps with wicks of moss. These houses are exceedingly close, and the only avenue through which air can enter is littered up with offal and filth of all kinds.

The paper was discussed by several members.

Prof. Mason inquired whether these people were much subject to diseases, such as consumption and rheumatism, and also relative to their longevity.

Mr. Petroff replied that they were subject to consumption. He thought that 50 years would be about the maximum age attained by them.

Major Powell remarked that the council-house is an institution common to many tribes, and that in most tribes it is called the sweat-house, or sudatory. He said that the Indian tent is a modern innovation, and that formerly they had dwellings of various kinds and materials. The skin tent was simply their portable shelter, besides which they had permanent ones. He also spoke of the great power of tribes to adapt themselves to their environment, and described the natural development of the pueblo dwellings and fortified villages from a primitive origin in mere temporary piles of loose stones thrown up for protection.

Dr. Reynolds stated that in Portugal, where soap was often very

dear or difficult to obtain, clothes were sometimes washed in urine as a substitute for it.

Dr. Morgan regarded the statement that the Innuits drank sea-water as very remarkable and unparalleled; he said he had heard that those shipwrecked sailors who remain in the water hold out longest owing to absorption through the pores of their skin, but they eventually die of thirst.

Mr. Petroff replied that he had employed them to take him out to sea, and seen them drink sea-water, never asking him for any of the fresh water he took with him.

Mr. Guss asked how far out to sea they ever ventured, and Mr. Petroff answered that they frequently went out of sight of land.

Dr. A. F. A. King read a paper entitled "THE EVOLUTION OF MARRIAGE CEREMONIES AND ITS IMPORT," in which he endeavored to show:

1. That primitive man, probably, had no marriage ceremony, but was governed in his sexual relations very much after the manner of brute animals, according to the "law of battle" among males, and the law of "sexual selection."

2. That the beginning of marriage ceremonies grew out of elements appertaining to social evolution and were not due to any anatomical or physiological changes in the organism, and resulted in the practical setting aside of the old law of "sexual selection;" just as at the present day we know marriages are most frequently determined by qualifications as to property, education, social position, political influence, &c., &c.

3. By the same factors the law of what he termed "œstruational selection" or "recurrent sexual coincidence" had been practically set aside. The natural working of this law provided that the human female (like the females of other beings) should only admit approaches of the male at periods more or less coincident with the epochs of ovulation. It, therefore, contributed to promote reproduction and perpetuation of the species. It accorded the female the privilege of consent or refusal. Throughout nature the male was the wooer, the female was wooed. It secured the female the

liberty of refusal during gestation, as well as the power to decline additional males when her physiological wants had recently been satisfied. Female animals were endowed with ample means of protection from the approaches of unwelcome males. It can scarcely be otherwise than that woman originally possessed the same privilege.

In connection with this part of the subject Dr. King referred to the views of McLennan, Lubbock, Spencer, and others, in support of the idea that the social evolution of the human race had been accompanied by phases of development, in which women had been made the slaves of men and had been bought and sold as wives, or betrothed for a consideration when infants, and subjected to marriage consummation regardless of any expressed desire or physiological want. Our own marriage customs were an outgrowth of these early phases of social evolution.

In conclusion Dr. King stated his belief that the present system of marriage among civilized peoples was, all things considered, the best that could possibly be devised. Monogamy, in order to satisfy the physiological wants of civilized males, may necessitate violation of the law of "œstruational selection" and compel the continuance of sexual union during pregnancy, and this, in its turn, might add to the ills of woman and multiply the diseases peculiar to her sex; but it was nevertheless a necessity, inseparable from the usages and maintenance of a high civilization. We might as well settle down to the conviction, once and for all, that it was useless to attempt a strict adherence to physiological laws and at the same time regard the requirements of civilized life; and hence had arisen, with the growth of every form of civilization, the enactment of State laws and the development of religions, without which the control and subjugation of natural instincts, in a way to secure the best results to all individuals composing a community, would be impossible.

Mr. Ward made some remarks on the portion of the paper which referred to the great difference between the sexual habits of human beings and of animals. He applied to the phenomenon as mani-

fested by man the term "male sexual selection" which he put in contrast with sexual selection proper as described by Darwin, and which is female sexual selection. This last he claimed was in turn due to natural selection, and the chivalrous deportment of male animals towards the females, which alone enabled the latter to select, had resulted from the natural selection of those species displaying it most by the inevitable extermination of those that sought gratification by force after the manner of uncivilized man. He regarded male sexual selection as a purely psychological phenomenon, and due to the influence of the mind in bringing about changes in the sexual habits of the human female. Both sexes becoming rational through the development of the brain, the males learned by various manifestations of cunning to influence the females in the direction of overcoming the apathies and aversions which nature gives her as a protection to her sex. Man appealed to woman's imagination and to her reason, faculties wanting in the lower animals; through appeals to her imagination he was gradually able to excite sexual feeling in her at times when pure instinct forbade it; through appeals to her reason he was able to secure submission at such times in exchange for other favors which he could confer and of which she in her subject state stood in great need. Even sexual caste, and the reverence of the women for the men by which the latter further secure the submission of the former at unnatural periods, is possible only to beings with developed mental faculties. In these and other ways a complete revolution in the sexual nature of woman had been produced. It must have taken place as gradually as cerebral development itself, otherwise adaptation would have been impossible. By it men, instead of being chosen by women, became the choosers of their wives, and female, had been converted into male sexual selection. Remarkable morphological changes had been the result, and just as in animals under female sexual selection male beauty had been produced, so in man under male selection female beauty had become predominant. He remarked upon the scarcity of scientific data on this

important question, and thought that medical men and biologists should take up and prosecute the investigation of comparative ovulation, menstruation, and sexual physiology.

Major Powell stated that the social life of savages had been much falsified by unscientific travelers seeking to invent large stories of their adventures among them; that in none of the tribes of North American Indians with which he was acquainted were children maltreated or women made slaves. On the contrary, the wife always belongs to a different gens from the husband, and he dare not harm her on penalty of vengeance from her own kinsfolk. He also said that there existed a fair division of labor between the sexes. The men provided for their families and the women performed the domestic service. He had seen much affection manifested between husbands and wives and by parents for children. Stories of infanticide were usually false. The theories of McLennan and Lubbock, relative to exogamy and endogamy, applied to none of our Indians, and he believed it to be wholly unsound, and due to superficial investigation, and especially to the confounding of the gens with the tribe. Marriage may occur within the tribe, but not within the gens; and different observers, utterly ignorant of their social system, have at times reported facts of the one and at times of the other of these classes, and created a totally false impression.

Mr. Dorsey made a few remarks strongly confirmatory of Major Powell's statements.

Dr. King asked whether the tribes under consideration did not occupy a comparatively high social position, and whether the theories combated might not hold true for much lower races.

Major Powell replied that for all tribes known to him, or from which any reliable accounts had been received, this was not the case.

THIRTY-SIXTH REGULAR MEETING, March 15, 1881.

Mr. Lester F. Ward read a paper entitled *POLITICO-SOCIAL FUNCTIONS*.¹

¹ "Penn Monthly," Vol. XII, May, 1881, pp. 321-336.

The principal object of this paper was to point out the wide schism which exists at the present epoch between the theories of political economists and the practices of States. The former are dominated by the negative ideas of Adam Smith and the English doctrinaires which constitute nearly all the literature of the subject, and are taught and professed almost universally. Notwithstanding this it was shown by profuse illustrations from history and statistics that the policy pursued by the various governments of the world is totally opposed to these teachings, and scarcely at all affected by them. The political economists declare that the true province of government is simply to protect the spontaneous operation of natural laws working in society, which will then work out all the results of civilization, and that any interference with these natural operations will be either wholly inoperative or will result in mischief. They found their doctrines upon the observed phenomena of the physical world which are known to be uniform and invariable. This they hold to constitute true political science, analogous to all physical science.

Notwithstanding the unanimity of writers, past and present, on this subject, positive state regulation, especially during the last quarter of a century, has made rapid strides, and nearly all civilized governments are openly violating these economic rules. The post office, the telegraphs, and the railways of many countries are passing under government control, while national banking and national education are rapidly superseding private banking and private instruction.

It was further shown that the desire for positive regulation consists for the most part of a mere intuition, or social instinct, and coexists, even in the same individual, to a great extent with the incompatible belief in the *laissez faire* policy of the schools. This greatly complicates the problem, and renders it highly important that a clear exposition of the grounds on which the positive policy is conducted be made. In seeking to do this it was shown that the unrestrained operations of natural laws in social phenomena invariably result:

1. In unjustifiable inequalities in the distribution of wealth, due to the general truth that there is no necessary harmony between natural law and human advantage.

2. In enormous waste of created products, due to the ruinous excesses of competition, entailing failures and losses.

3. In artificially increased prices, due to over-supply, the result also of competition, especially in distributive industries.

4. In dangerous monopolies, whether industrial or financial, which threaten to enslave labor and dictate commerce.

These propositions were supported by statistics of corporations and of public and local debts. It was also argued that, from the standpoint of science and the laws of evolution, all these results are the normal and legitimate products of natural law, and that there is no tendency in unregulated nature to reverse the process and disentangle these complicated social phenomena.

It was moreover denied that all attempts at government regulation had proved failures or resulted in an excess of evil to society. The various industries which have been absorbed by government and successfully conducted were enumerated at length, and it was shown that there were many such in this country, still more in Great Britain, and a maximum number on the continent of Europe. The extent of State ownership and management of telegraph lines in England and in Europe generally, and of railroads in Germany, France, Belgium, and Italy was exhibited by facts and figures; the prevalence of national savings banks throughout Europe and the character of the systems of education of Germany, Austria, France, and England were adduced in support of this view, as also the tendency now manifest towards the protection of home industries throughout the world.

From this basis of facts and from history the broader generalization was then made, that all the now recognized government functions have once been under a system of private management, and have had, each in its turn, to pass through the stage of opposition from those who would keep them so, and one by one have gradu-

ally taken their places as integral parts of the system of government. Finance and jurisprudence were given as examples of this truth, the former of which has scarcely as yet and the latter only quite recently assumed its true position. This process is moreover destined to continue, until all truly public operations shall come more or less directly under the power of state regulation. Contrary to the general belief, this result is not often reached before the time is ripe for it. Such is the aversion to innovation that the evils of private management usually become well nigh intolerable before the state is able or willing to step in and relieve them.

The want of an adequate term for expressing this conception of the assumption by the state of the control of interests of a public nature was next pointed out, and it was proposed to designate the entire movement by the name *Sociocracy*, as a new word, etymologically akin to *sociology*, and avoiding the stigma which attaches to all expressions for the government regulation of industries whose public nature is disputed. This term embraces all the functions of government, whether universally acquiesced in or not. It also conveys a distinctly different meaning from either *democracy* or *socialism*, and stands simply for positive social action as opposed to the negative or *laissez faire* policy of the predominant school of politico-economic doctrinaires. It recognizes all forms of government as legitimate, and, ignoring form, goes to the substance and denotes that, in whatever manner organized, it is the duty of society to act consciously and intelligently, as becomes an enlightened age, in the direction of guarding its own interests and working out its own destiny.

President Powell remarked that it was a curious fact that no college teaches the positive doctrines of political economy, carried out to so large an extent by the government. He said that the doctrines taught by Herbert Spencer and that school, would, at a rough estimate, if practiced, neutralize nine-tenths of the legislation of the world. Modern legislators, while professing to sub-

scribe to these doctrines, are in practice chiefly employed in considering to what extent they shall be violated. He further pointed out the fact that the theories now prevailing became popular at a time when government was unpopular, which is not now the case, the latter having become representative in form. Former attempts at government regulation were impracticable, because they sought to control opinion. The form of control now exercised is of a very different kind, and is practicable and effective. He showed that the natural evolution of industry was legitimate and harmless so long as it was confined, as it must necessarily be at first, to simple differentiation, but when the differentiated parts commenced to become integrated, there arose grave social evils. He was not hostile to corporations, but held that they were the instruments through which nearly all the operations of society would eventually be performed. But they require regulation, and he thought that the principal work of legislation would ultimately be the adjustment of the relations of corporations to the public and to each other. Government has developed from its primary condition—the family. Feudalism was the transition stage from kinship government to property government. Modern civilized society is based on property, the unit being the individual. He believed that the social unit will eventually be a business corporation, and that there will be a hierarchy of corporations, the highest of which will embrace all the rest and constitute the government. The basis of society will then cease to be property, and will become industry.

Dr. Rock said that the policy and interests of all nations seemed to be growing more and more uniform, and he thought that this tendency was in the direction of an ultimate consolidation of all nations under one government. In South America nearly all industries were under the control of foreign companies and capitalists, and it was a common saying there that it made little difference how much was produced, the people could not retain any of it, as it all goes to London or some other wealthy foreign mart. Hence the necessity of nations being self-sustaining.

Prof. Otis T. Mason commenced to read a paper entitled *THE SAVAGE MIND IN THE PRESENCE OF CIVILIZATION*, but the hour of adjournment arrived before he had completed it.

THIRTY-SEVENTH REGULAR MEETING, April 5, 1881.

Professor Otis T. Mason concluded the reading of his paper commenced at the preceding meeting, entitled *THE SAVAGE MIND IN THE PRESENCE OF CIVILIZATION*. The following abstract has been furnished :

1. The progress of civilization has been guided and stimulated in every age by the presence of peoples more advanced in any regard. It is impossible for beings constituted as we are to look upon the processes or results of industry different from or more advanced than their own without emotion, accompanied with emulation or despair, according as the object may or may not be beyond their reach.

2. Theoretically this fact is related to chronology, reversion, flexibility of races, technology, language, social system, and religion.

3. There are certain lines or categories of culture, such as food, dress, shelter, war, industry, ornament, gratification, traffic, family organization, government, and religion, along which there has been evolution and elaboration.

4. Among these categories themselves there is gradation, nearly in the order named above. It is more difficult for a people to change in the higher and more intellectual than in the lower categories. It is, therefore, easier to induce a people to change food, dress, implements, weapons, &c., than to alter their language, kinship, government, and religion.

5. In each class or line there may be, and probably are, well marked stages of progress, corresponding to Mr. Morgan's periods. If the categories, therefore, are represented by parallel perpendicular lines, the total simultaneity would be marked by lines like parallels of latitude or isotherms crossing the categories.

6. Attempts to leap over these consecutive steps of culture, or to substitute progress in one category for that in another, ignoring the intermediate ones, have been fatal in several ways: 1. They have presented a discouraging chasm between the starting point and that to be reached. 2. The transition has made unnatural and frequently fatal strains upon the organism, both in its physical and psychical constitution. 3. If by reason of mixed blood or extraordinary natural gifts the subject be forced to the status of the higher race, he is still ostracised. He cannot compete with the dominant race against capital, inherited proclivities, and racial prejudice. On returning to his own people he is spurned for his ignorance of the old paths, and is unable to induce his people to don the new fashions. The experience of nearly all authors whom I have consulted is that these highly stimulated savages either perish miserably or become lazaroni among their own people or the dominant race.

7. In conclusion, it is strongly insisted on that the only valuable education to a lower race is that which enables the subjects to develop their highest energies and intelligence among those where their lives are to be passed. In its true and widest sense education is not confined to school instruction. It embraces all that changes in the presence of higher culture. It cannot be too strongly insisted upon that functions vary easier than structure. Just as it is difficult to change the structure of a tree, which nevertheless we may use for fruit, for shade, for ornament, or for timber, almost indifferently; or the structure of a horse which the farmer may employ almost equally in the thousand and one operations of his craft; so is it with this wonderful organism called society. Functions may change many times in the life of an individual, but the edifice of the body politic, the family, and the church, can be reconstructed only with the greatest wisdom and patience.

President Powell remarked relative to the efforts described by Prof. Mason, which had been and were being made to educate the Indians in special schools and institutions for the purpose, situated

in civilized communities, that they had generally proved failures, and would in his opinion continue to prove such. Those persons thus educated usually become worthless citizens either of their own or of civilized communities. He claimed that the facts, and his conclusions drawn from them, were based on broad ethnological principles, and the movement was conducted in ignorance or disregard of those principles. He had at one time contemplated giving publicity to his views on the subject, but was dissuaded from so doing by a consideration of the worthy and philanthropic motives from which these efforts proceed. He urged that if they are to be continued it is important that the subjects for such education be selected from the most advanced tribes, and those which had been longest in immediate communication with the whites. He thought, however, that the Indians were really becoming rapidly civilized, especially in reservations where they come into constant contact with the whites. They are learning how to dress, to do business, to use money, and to travel, and the schools established among themselves are doing great good. He further stated that on visiting the Numas he had been surprised at finding two distinct kinds or sets of governments coexisting among them at the same time, and two chiefs, each apparently supreme. On investigation he learned that the regular chief or medicine-man had little or nothing to do with the practical affairs of the tribe, and that the virtual chief had slowly been developed from the condition of interpreter or "talker," who at first was selected for his ability in conducting the business of the people with the surrounding whites; and as this business became more and more important, his powers became greater and greater until he has at length come to be regarded as the real chief of the tribe.

Dr. Welling corroborated the remarks of Major Powell, and instanced the case of an African missionary who, after a lengthy sojourn among the lower tribes, returned convinced that missionary work among them must remain next to useless until the practical civilizing agencies, such as the mechanic arts and the schoolmaster,

can be made to accompany and reinforce it. He thought that the efforts in question were useful only in furnishing high ideals, and keeping them before the minds of men.

Mr. Ward inquired whether there was any evidence of nominal subordination of the virtual to the regular chief, analogous to that which exists in many countries where the Prime Minister is the virtual ruler, and the hereditary king or queen a mere figure-head.

Major Powell replied that such evidence existed, and gave an illustration in support of that view.

Dr. Fletcher commenced to read a paper entitled CRANIAL AMULETS AND PREHISTORIC TREPHINING,¹ which was continued to the next meeting.

THIRTY-EIGHTH REGULAR MEETING, April 19, 1881.

Dr. Robert Fletcher concluded the reading of his paper entitled CRANIAL AMULETS AND PREHISTORIC TREPHINING, of which the following is an abstract:

The first communication upon the subject of cranial amulets was made by Prunières to the French Association for the Advancement of Science, at their meeting held at Lyons, in 1873. He presented what he termed a "rondelle," discovered in the interior of a skull in one of the dolmens of La Lozère. A large portion of the skull had been removed, apparently by some rude instrument. Other discoveries of a similar character continued to be made, and it was for some time supposed by Prunières that the condition of the fragments resulted from attempts to make drinking cups of the skulls. When they were submitted to Broca for examination, he at once asserted that certain parts of the edges of the rondelles and of the apertures in the crania gave evidence of reparative process, and that an operation, resembling that known to us as trephining, must

¹ Will appear in full in "Contributions to North American Ethnology," vol. V, pp. 1-32, with plates.

have been performed, and which the patient must have survived many years.

That no weapon could have produced the openings found in these crania was demonstrated by drawings showing the effect of sabre cuts and of contused blows. A remarkable peculiarity observed was that a small portion, at least, of the cicatrized edge was left on the rondelles and on the apertures in the skulls. The difference between this cicatrized edge, with its rounded ivory-like surface and the sharp edges produced by sections made after death, were easily discerned.

The evidence (which was very fully given) led Broca to the conclusion that the operation was performed on very young children; that it probably had no religious significance, but that it was intended for the relief of fits or other nervous disorders. A like operation is performed to this day by natives of the Polynesian Islands, and for a similar purpose.

Broca believed that the operation was performed by scraping, and he produced very similar results on the dry skull, and on a living puppy, with pieces of flint. The cicatrized apertures, when undisfigured by post-mortem incisions, are of an ovoid shape with edges widely beveled at the expense of the outer table. Lucas-Championnière produced a similar result by drilling a series of holes in a skull with a pointed instrument, running them into each other so as to enable the fragment of bone to be removed, and afterwards scraping the serrated edges smooth.

Certain tribes of Kabyles practise the operation in this manner at the present time, the operator, the instruments, and the dressings all having a semi-sacred character. It is performed by them as a means of relief for pains in the head, but chiefly after injuries by stones, which are the ready and common weapons of offense in their sterile land.

Although by far the largest number of cranial amulets and trephined skulls now stored in the anthropological museums of Europe have been discovered in France, yet similar relics have been found

in many parts of Germany, in Denmark, Russia, Portugal, and Algeria. [A full account was given of these explorations.] Nothing of the kind has, so far, been found in Great Britain.

In the United States no specimen that can be classed with the custom under discussion has been discovered. In 1875, Mr. Henry Gilman described some perforated crania which he had exhumed from mounds on Sable river, but the aperture was, in each case, at the vertex, and unmistakeably produced on the dried skull.

The famous Inca skull brought by Mr. Squier from Peru, and presented to the Paris Society of Anthropology, exhibits a remarkable instance of trephining which the patient must have survived about ten days, in the opinion of Broca and Nélaton. The operation, however, was entirely unlike that of the neolithic age; two incisions, made apparently by a saw, were crossed by two others at right angles, thus removing a square piece of bone. Mr. Squier was of opinion that the skull was of undoubted pre-Columbian date.

Since the publication of Broca's papers on this subject, discoveries have been made showing that prehistoric trephining was sometimes practised on grown persons, and for diseases of the bones of the cranium. Another curious discovery was made of skulls (about twenty in all) in which an incomplete operation had been performed, the outer table, only, having been scraped away. A similar operation has in later times been recommended for the cure of epilepsy.

It has been suggested that the tonsure of priests was a perpetuation of this curious custom.

The conclusions arrived at by the writer were these:

1. The large number of perforated neolithic crania exhibiting cicatrized edges, establishes the existence of a custom of trephining.
2. The operation was performed on both sexes, and generally at an early age.
3. The purpose is doubtful, but from analogy it would seem to

have been for the relief of disease of brain, injury of skull, epilepsy, or convulsions.

4. The operation was probably performed by scraping ; possibly by a series of punctures. It seems likely that the first was employed for children, and the latter for the harder skulls of adults.

5. Posthumous trephining consisted in removing fragments of the skull of a person upon whom surgical trephining had been performed.

6. Each fragment was to exhibit a portion of the cicatrized edge of the original operation ; and the purpose was, probably, to form an amulet to protect from the same disease or injury, for relief of which the operation had been performed.

In reply to a question by Prof. Mason, Dr. Fletcher explained that the Inca skull appeared to have been perforated by some saw-like instrument, and that the operation was probably performed only a few days before death.

The President remarked that among Indians pathology consists of a sort of mythical zoölogy ; that local diseases, such as sore eyes, boils, etc., are attributed by them to the presence of worms, flies, bees, etc., regarded as incorporated spirits. Their method of curing such diseases consisted, therefore, in making openings for the escape of these creatures. This was their conception of the efficacy of blood-letting, which was extensively practiced. The disease-organism escaped with the blood. Sealing was resorted to for the same purpose, and a variety of punctures were made, differing in different cases. He suggested that all the cases of cranial perforation might be accounted for as so many modes of letting out the headache spirit or animal.

Prof. Gore stated that he had observed in the Medical Museum perforated skulls, containing within loose pieces of skull of larger size than the orifice, and which, therefore, could not consist of the piece cut out.

Dr. Fletcher thought that none of these various forms of skull perforations had any relation to the practice of trephining.

Dr. H. C. Yarrow then read a paper entitled *SOME SUPERSTITIONS OF THE SIOUX INDIANS*.¹

The reader disclaimed presenting the paper as an original effort, the material having been furnished by Dr. Merritt, of the army, who obtained it from Mr. Wm. Everett, a Government scout. He considered that gentleman entitled to great credit for the account. Mr. Everett stated that the Sioux believe they go direct to the happy hunting grounds, after passing a great divide upon which their dead enemies attack them, and for this reason they need their horses, weapons, &c. If the spirit pass unscathed and reach the desired haven the friends who have gone before meet them, and all is joy. If they have lost members of the body, or been mutilated, all is restored as before at this place. Their idea of sickness is that a bad spirit enters the body and must be driven out. If the patient dies he has been conquered by the bad spirit. The spirits of bad Indians are sometimes sent back to earth to do penance for their sins, in the shape of animals. The men are supposed to turn into buffaloes, wolves, and bears; the women into deer or owls. A curious example was given of a conversation which took place between Sitting Bull and a wolf in regard to the position of a herd of buffaloes. The awe the Indians experience regarding the white-tailed deer was described. It is thought that women become deer after death, and an Indian dislikes to kill one of these animals, for fear of hurting the spirit of his sweetheart. It is believed, too, that hunters have been found strangled by the white-tailed deer spirits, and a story was given in detail how a number of youth perished who were foolhardy in hunting them.

The President made the general comment upon the legends recorded in the paper that they appeared to have been largely colored by conceptions of white men engrafted upon them.

¹ Published in full in the "American Antiquarian and Oriental Journal," No. XIV, Vol. IV, 1882, pp. 136-144.

The following paper was then read by Rev. J. Owen Dorsey:
THE YOUNG CHIEF AND THE THUNDERS: AN OMAHA MYTH.

Once there was a great chief, who had a lazy son. In spite of all the advice which his father gave him he spent all of his time in eating and sleeping. He would neither travel nor take a wife. At length he had a separate lodge made for him. He entered it and fasted for four seasons, speaking to no one. Only once in a while he took very small supplies of food and water, which his mother brought him. As he fasted, he saw a deity, who told him that he could do whatever he desired, and he thought that he would like to wear a robe of scalps; so he summoned the young men of the tribe, and made up a war party, which started in four days. At length they came to an old man, who was very poor. No one but the chief knew that he was a Thunder. They pitied him, and gave him some of their robes, etc. The old man spoke of giving them something in return. Just then his servant, a coyote, winked at the chief, who followed him out of the lodge. The coyote told him to choose the otter-skin sacred bag, when the old man showed him that and three others. They re-entered the lodge. The old man asked them which one of the four sacred bags they would take. The swallow bag would insure a return in half a day, with scalps, etc; the hawk bag would bring them home triumphant in two days; the third would keep them away a little longer. "As for this otter-skin," said he, "it is good; but it is old and worn." And, grasping the otter-skin, the chief said, "Notwithstanding that, grandfather, I will take that," and the old man was in a bad humor and scolded his servant. "No, grandfather," said the chief, "he did not tell me. I chanced to decide so." And the old man gave him a wooden club with the otter-skin bag. "The owner of the bag does whatsoever he desires, in spite of all difficulties. It kills a great many people. If you wish to kill all the people in any place, whirl this club around your head four times, and at the last time say 'Kau.' It will make thunder." The old man knew the desire of the chief. Four days after that the chief sent out four

scouts. They found a village. When the party reached the village the chief told them that he was not seeking it, but something else. There were similar occurrences on three successive days. On the fourth day he sent out scouts again, saying: "Warriors, should one of your grandfathers be there, do not kill him." They met a buffalo, and, after some disputing, one shot at it, and the buffalo killed him. The survivors reported this to the chief, who said, "Did not I tell you not to harm your grandfather?" On reaching the body they buried it and passed on. The next day, after a similar warning, the scouts attacked a big wolf that killed one of their party; so on the third day, when they met a grizzly bear. On the fourth day they came to the end of the sky, which passed up and down very rapidly. Each time it went down into a deep chasm in the earth. The chief warned the warriors to jump across without fear. He was the first, and all but one followed in safety. One failed, and the end of the sky carried him down into the earth. So they went and went, for days. At last they saw a very high hill and a dense cedar forest. The men had become tired of journeying so far. "Well, warriors," said the chief, "we are going thither. We will then return home." Four scouts were sent out. They saw the smoke, but could not find the lodge. It was not till the fourth day that the scouts for that day found the lodge, which all entered. There sat a very aged man, with an unusually large head and plenty of white hair. (He was a Thunder.) The old man thought, "Though my brothers may have much trouble by going to so great a distance hunting for game, some men have brought themselves right into this lodge, where I can kill them with ease." The chief thought, "Whew! I have said that I would have a robe of scalps. I think that here is the very thing. I will have it." By and by another old man entered, bringing a black bear. He, too, had a large head, and his hair was very red. A third old man, with very yellow hair, came with a buffalo. The fourth brother, who had very green hair, brought the body of a man; and he who had red hair said, "Brother, have these men eaten?" "No, they

have not eaten. Cook for them slices of squash," said the one with white hair; and they cooked the ears of the dead man. "We do not eat such things," said the chief. "If so, what do you eat?" said the old man, pretending that he thought they did not like sliced squash. "Cook ye fine sweet corn for them," said he, meaning lice. When the chief saw what it was, he said, "We do not eat such things." And one of the Thunders said, "Let them cook the bear and buffalo for themselves." And the men were glad. Having done their own cooking, they had pleasure in eating. Then it was night. After the meal the man with white hair said, "Grandchild, if a man travels he has plenty of things to talk about. Tell about yourself." "True, grandfather," said the chief, "you are grown, and are an old man, so you must know a great many things. So you can tell about yourself first." "Well, grandchild, though I am an old man, I have nothing to tell about myself; but I will tell a myth." "Once upon a time, grandchild, there was an old man, who lived with his three brothers. The brothers went far away to hunt game; but they returned home at night. Once when the old man was the only one taking care of the lodge, a great many people entered it. The old man thought, 'Though my brothers have undergone much in travelling so far after game, I will kill a great many persons right at home.' Come, grandchild, now is your turn." "Yes, grandfather, let me tell a myth. Once there was a powerful chief, who had a lazy son. Though his father frequently urged him to travel, he would not heed him. He had not the least desire to do anything. By and by the son said that he was going to fast, so his mother made a lodge for him. As he fasted, he thought he would like to wear a robe of scalps, so he went on the war-path with many followers. And there were four old men who lived together. The chief and his party went thither. When they reached the lodge the leader sat thinking, 'I have said I will wear a robe of scalps. Truly, this is a good robe. I will have it.' One of the old men had white hair, one had red, the third had yellow, and the fourth green hair."

And the old man laughed at him, "Ha! Ha! Ha! My grandchild has, I think, guessed the very thing." That night the chief lay with his eye peeping through a hole in his robe, as he wished to watch the old men. He told his men not to sleep. While they were lying the first old man lifted his head very cautiously, and looked at the (supposed) sleepers. At last the old man seized his hammer, but just then the chief sprung to his feet, whirled his club, and at the fourth time, said, "Kau." He killed the four old men. "Warriors, arise, and take the hair of all; take each scalp in one piece." Then they went home. When they reached the end of the sky the chief made his men jump across in advance of him. Running very fast, he made a flying leap, bringing up the man from the ground, and reaching the other side, both being alive. He did in like manner at the graves of those who were killed by the bear, wolf, and buffalo. Thus it happened that he took all of his men home alive. As they went home they saw the many villages which they had reported to the chief on their former march. "Well, warriors," said the chief, "you, too, shall wear robes of scalps." So he killed the people of four villages with his club, and gave to each of his friends enough scalps for a robe. And they reached their own village, and all his villages made him head chief, and he governed them.

The President inquired whether the legend was taken literally from the Indians, and Mr. Dorsey replied that he wrote it out as dictated to him by one of them.

Prof. Mason referred to the tendency of such stories to grow by repetition.

Mr. Dorsey said he had often obtained two or three different versions of the same myth.

THIRTY-NINTH REGULAR MEETING, May 3, 1881.

Dr. Clay MacCauley read a paper entitled PERSONAL CHARACTERISTICS OF THE FLORIDA SEMINOLES.

Dr. MacCauley prefaced his paper with a statement of some interesting facts he had found in taking a census of the Florida Indians. Chief among them was the peculiarity of special moment to the future of the tribe, that, while Seminole society is polygamous, the number of males in it between five and twenty years of age far exceeds that of the females less than twenty years old.

In reference to the personal characteristics of this tribe of Indians the speaker turned attention to their physique, their manner of clothing themselves, their personal adornment, and their psychical qualities, successively, giving ample description and copious illustration to each part of his subject.

The paper, of which it is difficult to make a proper abstract, closed with the words: "Recalling, then, what I have recorded of my observations of the personal characteristics of the Florida Indians, they present themselves as a unique people, as a rule, superior to a high degree in their physical development of form and feature, novel and curious in their costume, and peculiar in the ornamentation of their persons and clothing; and, so far as personal characteristics distinctively psychical are concerned, as a people, not only, as was hitherto acknowledged, brave in warfare, and proud and independent in their relations with the white man, but also well endowed with the gentler and more attractive personal traits, amiability, truthfulness, frankness, and geniality in their intercourse with those who have gained their confidence, and gifted with comparative excellence of intellectual faculties and activity, patience, and persistence in mental effort."

At the conclusion of the paper Prof. Mason inquired whether the well developed limbs described as characteristic of the Seminoles might not in some cases be due to bandaging and other artificial devices sometimes resorted to by savages.

Dr. MacCauley replied that, as the children always go naked, this was impossible; and he was sure that no such practices prevailed. In answer to further questions, he stated that the hole

pierced in their ears were very small, but often numerous; that he had not seen shells or pearl beads used as ornaments.

Dr. Antisell asked what the Government was doing to benefit these Indians, and Dr. MacCauley replied that nothing was being done; that the Seminoles refused to accept any aid, and were independent without any. The attempt of Capt. Pratt to obtain from them students for his school at Carlisle had been repelled with indignation. In reply to a question by Mr. Thomas, he further stated that the Creek and Seminole languages were originally the same, but that at present the several gentes of the Seminoles were not homogeneous. The Otter, Tiger, and Wind gentes are the ruling ones.

The President called attention to the term Seminole, which properly signifies renegade, scattered, or dispersed, and has been fastened upon these Indians because they refused to go with the body of their tribe after the war with the United States. He further remarked that with these Indians clothing seemed to have been originally used for ornament rather than protection. The lower garment, or petticoat, described by Dr. MacCauley, was formerly the only one worn by the women, who had no sense of modesty which required them to clothe the breasts. The short upper garment, now worn as described in the paper, was a modern innovation probably taken from the whites. He also spoke of the turban, which was originally purely ornamental, and was often made in fantastic fashions out of the skins of the heads of animals or large birds.

Prof. Mason called attention to the law of ethnic progress that customs relating to clothing, ornamentation, &c., yield less readily and quickly to the influence of contact with civilized races than do those of a more practical or industrial character, such as arms, agricultural and mechanical implements and pottery. He had often been surprised to observe along what irregular and, as it were, irrationally drawn lines civilization advances.

FORTIETH REGULAR MEETING, May 17, 1881.

Dr. W. J. Hoffman read a paper entitled THE APPLICATION OF GESTURES TO THE INTERPRETATION OF PICTOGRAPHS. The following is an abstract of the paper :

The speaker stated that, apart from the direct representation of objects in the picture writings of the North American Indians, those subjective ideas which were beyond the range of the artist's skill formed the parts most difficult of interpretation. As attempts at the reproduction of gesture lines are of frequent occurrence in pictographs whose meaning is known to us, it was suggested that a knowledge of the gesture language was essential in deciphering others, the import of which was unknown. Numerous examples were submitted illustrating the gesture origin of apparently unintelligible characters, but as the nature of the paper demanded illustration on the black-board it is impossible to attempt an abstract satisfactorily.

Col. Mallery remarked that, as Dr. Hoffman and he had been working together on the subject of the paper, with constant interchange of views, he naturally had no criticism to offer upon it. It was, however, of interest to mention that the idea which had borne fruit in the present paper was suggested by him in some sentences of a paper read before this society on October 21, 1879—to the effect that Indians and other peoples among whom neither alphabetic nor phonetic writing was known, and whose artistic skill was limited to the rude outline portraiture of a few objects, would, in seeking to represent ideas graphically, resort to the lines of gesture signs already used by them with distinct signification. This deduction at the time was supported by little ascertained proof, but the subsequent studies both of signs and of pictographs had established it to be correct, of which the paper read was sufficient evidence to the Society. The same illustrations drawn on the black-board by Dr. Hoffman had also been drawn by him, together with others, for the engraver, and will be produced under one of

the headings of a work on sign language, which itself formed part of the Annual Report of the Bureau of Ethnology now in press.¹ Its publication will direct attention to the interpretation of ideographic characters in many parts of the world, through the significance of gesture signs, and also react upon the scientific study of sign language as a former general mode of communication between men. Though the published presentation of the suggestion had hitherto been imperfect, he had already received gratifying assurances from European scholars of their success in discovering gesture signs included in Egyptian and Akkad glyphs, as well as in the radicals of those languages. Mr. Hyde Clarke, Vice-President of the Anthropological Institute of Great Britain and Ireland, had specially shown interest in the investigation.

President Powell was glad to note that rational principles and methods were being applied to the solution of such questions. The true value of facts consists in their proper and rational interpretation. Human history is being rewritten to satisfy this sentiment. The isolated facts of the old style of chronological history are useless, and now it is necessary to go over the ground again, for the purpose of deducing from them the laws of progress and of society. It is the same with ethnological facts. These pictures convey no meaning in themselves, and the work of true science is to discover such laws as will lead to their proper interpretation.

FORTY-FIRST REGULAR MEETING, June 7, 1881.

Professor Samuel Porter read a paper entitled VOWEL SYSTEMIZATION, of which the following is an abstract:

On the theory of Helmholtz, the character of each vowel is produced by the reënforcement of harmonic tones in the oral cavity. That of Donders finds it in the noises that go with the tone. The truth lies in a combination of the two.

¹ "Sign Language among North American Indians compared with that among Other Peoples and Deaf-Mute." By Garrick Mallery. In "Annual Report of the Bureau of Ethnology," 1879-80, pp. 269-508.

In classifying the vowels we are to look to the positions and motions of the organs. The scheme of Mr. A. M. Bell assigns to each vowel a distinct palato-lingual position, to which may be superadded a labial or a nasal modification. It divides the vowels, "horizontally," into "back," "front," and "mixed," as the place of closest constriction falls on the soft or on the hard palate or in some sort between the two. These it subdivides, "vertically" (so described with questionable propriety, the subdivision being as truly horizontal as the main division), into "high," "mid," and "low." High-back: *pool*. Mid-back: *mōst*. Low-back: *saw*. High-front: *see*. Mid-front: *été* (Fr.). Low-front: *their*. High-mixed: *earth*. Mid-mixed: *gabe* (Ger.) Low-mixed: *bird*. These are the "primary" of Mr. Bell and the "narrow" of Mr. Henry Sweet; and for each there is a corresponding "wide:"—*e. g.* narrow: *peel, été, their*; wide: *pill, pet, that*. Labials are called "round;" thus, *pool* is high-back-narrow-round. Mr. Bell explains the wide by an expansion of the pharynx; Mr. Sweet, by a depression of the upper surface of the tongue. In this Prof. Porter agrees substantially with Mr. Sweet; but, instead of two, he would, for nearly all the vowels, mark four degrees, which he would call *close, half-open, open, and open-depressed*. Thus, the *i* half-open, as Frenchmen, Germans, and Scotchmen pronounce *bit, is, sick, position, &c.* The open depressed, a drawling, dialectic pronunciation of the short stopped vowels, *i, e, a*, and others; or, sometimes, properly used for emphasis; a natural concomitant of nasalization; also, the initial of some diphthongs, a depressed degree of the open *u*, in *but*, being the initial of our long *i*.

Prof. Porter would make only a two-fold instead of the three-fold subdivision of the "mixed," and would place in this class the French *eu* in most cases, and the German *ö* in at least many cases, and not among the "front" as a labialized *e*, as do Messrs. Bell and Sweet; and would place here the *u* in *up, but*, instead of among the "back" vowels.

Concerning the Italian *a*, the *a* in *father, ask, pass, etc.*, Prof.

Porter maintains that the place of constriction is not on tongue and palate, but between the back wall of the pharynx and the tongue at or just above the epiglottis. It belongs, therefore, not among the "back" vowels, but in a class by itself; and with this agrees the fact that the more open form of this vowel is the naturally long, while for all others the open, or "wide," is the naturally short. It is important to notice that the guttural passage, the *fauces*, may be so adjusted as to make a compartment distinct from the fore part of the mouth, and separated on the anterior edge of the *ramus* of the lower jaw. With the tongue for a floor, pharyngeal muscles for side walls, the elastic curtain of the soft palate for a roof, the muscular "pillars of the fauces" flanking the entrance, we have a chamber highly dilatable and contractible and adjustable in various ways. Prof. Porter holds that, for the Italian *a*, the resonance chamber is limited to the compartment made by this passage and the lower part of the pharynx. For the proper "back" vowels, *oo*, *o*, and *au*, the soft palate is curved forward toward the tongue, contracting the entrance and at the same time the walls of the passage, and extending the resonance chamber forward.

The number of possible vowel-modifications being theoretically infinite, a perfect system will mark just so many distinctions as will seem to be necessary and sufficient, considered as approximative points of reference.

Mr. Ward called attention to the similarity of the conclusions reached by Prof. Porter to those which he had announced in a paper read before the Society on the 21st of December last, and read a paragraph from the abstract of that paper as printed in the "Abstract of Transactions," (p. 106). He also testified to the general rationality and correctness of the order in which Prof. Porter had arranged the principal vowels with respect to the probable location of the sound in the mouth and pharynx. He commented upon Bell's chart representing his system of vowel sounds, and pointed out a number of inconsistencies in it.

President Powell said that in consequence of the infinite variety of possible sounds, it was impossible to classify them except by types. No two persons speak alike ; no two voices are alike ; and instrumental tests have shown that the same person cannot pronounce the same vowel twice in precisely the same way. Prof. Bell had frequently demonstrated this by means of the telephone. The effect on the instrument was different with each attempt, and having made a sound once he found that he could never exactly repeat it. The passage of a vibration of air through the complex mechanism of the human voice is so heterogeneous in its character that it is impossible for two men to utter precisely the same sound. Two sounds thus made may be very nearly but cannot be exactly the same.

In the course of his work during several years past, in endeavoring to devise an alphabet with which to write the sounds embraced in various Indian languages, he had come to the conclusion that he could not describe sounds by describing the way in which they are made ; that, in the present state of the science of phonology, it was only possible to compare them with those by which they would be recognized. He could only describe the way in which something like the sound is made. He therefore thought that a common system of pronunciation for all languages was a physical impossibility.

FORTY-SECOND REGULAR MEETING, June 21, 1881.

Prof. G. Brown Goode read a paper entitled THE FISHERMEN OF THE UNITED STATES. The following is an abstract :

For every man engaged in the fisheries there is at least one other man who is dependent to a considerable extent upon his labors for support. To the class of "shoresmen" belong (1) the capitalists who furnish supplies and apparatus for the use of the active fishermen ; (2) the shopkeepers from whom they purchase provisions and clothing ; and (3) the skilled laborers who manufacture

for them articles of apparel, shelter, and the apparatus of the trade. In addition to the professional fishermen, there is a large class of men who have been called "semi-professional" fishermen—men who derive from the fisheries less than half of their entire income. Taking into account all those persons who are directly employed in the fisheries for a larger or smaller portion of the year, those who are dependent upon fishermen in a commercial way for support, and the members of their families who are actually dependent upon their labors, it cannot be far out of the way to estimate the total number of persons dependent on the fisheries at from 800,000 to 1,000,000.

The total value of the product, *to the producers*, of the fisheries of the United States has not yet been definitely determined; but it will doubtless prove to be somewhere near forty-five millions of dollars. The value of the product, when it reaches the consumer is at least \$250,000,000. Of the thirty-one States and Territories whose citizens are engaged in the fishery industry, seventeen have more than a thousand professional fishermen. The most important of these States is, of course, Massachusetts, with from eighteen to twenty-five thousand men. Second stands Maine, with ten to twelve thousand, unless indeed the 16,000 oystermen of Virginia and the 15,000 of Maryland are allowed to swell the totals for those States. Maine, however, stands second so far as the fisheries proper are concerned. Third comes New York with about 5,000 men, then New Jersey with 4,000, North Carolina with 3,500, Oregon with its horde of salmon fishermen, 2,500 in number, Florida with 2,100, Connecticut and California with about 2,000 each, Michigan with 1,781, Wisconsin with 800, Georgia with 1,400, Ohio with 1,046, Delaware, Rhode Island, and South Carolina, each with about 1,000, New Hampshire, Alabama, Louisiana, and Texas with about 400 each, and Mississippi with only 60.

The majority of our fishermen are native-born citizens of the United States, although in certain localities there are extensive

communities of foreigners. Most numerous of these are the natives of the British provinces, of whom there are at least 4,000 employed in the fisheries of New England. There are, probably, not less than 2,000 Portuguese, chiefly the natives of the Azores and of the Cape Verd Islands. Very many of the Portuguese have brought their families with them, and have built up extensive communities in the towns whence they sail upon their fishing voyages. There are also about 1,000 Scandinavians, 1,000 or more of Irish and English birth, a considerable number of French, Italians, Austrians, Minorcans, Slavs, Greeks, Spaniards, and Germans. In the whaling fleet may be found Lascars, Malays, and a larger number of Kanakas, or natives of the various South Sea Islands. In the whale fishery of Southern New England, a considerable number of men of partial Indian descent may be found, and in the fisheries of the Great Lakes—especially those of Lake Superior and the vicinity of Mackinaw—Indians and Indian half-breeds are employed.

The salmon and other fisheries of Puget Sound are prosecuted chiefly by the aid of Indian fishermen. In Alaska, where the population depends almost entirely upon the fisheries for support, the head of every family is a professional fisherman, and, upon a very low estimate, one-fourth of the inhabitants of Alaska should be considered as fishermen. Few of them catch fish for the use of others than their own immediate dependents. Only one Chinaman has, as yet, enrolled himself among the fishermen of the Atlantic coast, but in California and Oregon there are about 4,000 of these men, all of whom, excepting about 300, are employed as factory hands in the salmon canneries of the Sacramento and Columbia basins. The 300 who have the right to be classed among the actual fishermen, live for the most part in California, and the product of their industry is, to a very great extent, exported to China; although they supply the local demands of their countrymen resident on the Pacific coast.

The negro element in the fishing population is somewhat extensive. We have no means of ascertaining how many of this race

are included among the native born Americans returned by the census reporters. The shad fisheries of the South are prosecuted chiefly by the use of negro muscle, and probably not less than four or five thousand of these men are employed during the shad and herring season in setting and hauling the seines. The only locality where negroes participate to a large extent in the shore fisheries is Key West, Fla., where the natives of the Bahamas—both negro and white—are considered among the most skillful of the sponge and market fishermen. Negroes are rarely found, however, upon the sea-going fishing vessels of the North. There is not a single negro among the 5,000 fishermen of Gloucester, and their absence on the other fishing vessels of New England is no less noteworthy. There is, however, a considerable sprinkling of negroes among the crews of the whaling vessels of Provincetown and New Bedford, the latter alone reporting over 200. These men are, for the most part, natives of the West India Islands, such as Jamaica and St. Croix, where the American whalers engaging in the Atlantic fishery are accustomed to make harbor for recruiting and enrolling their crews. As a counterpart of the solitary Chinaman engaged in the Atlantic fisheries we hear of a solitary negro on the Pacific coast, a lone fisherman, who sits on the wharf at New Tacoma, Washington Territory, and fishes to supply the local market.

The number of foreign fishermen in the United States, excluding 5,000 negroes, and 8,000 Indians and Esquimaux, who are considered to be native-born citizens, probably does not exceed 10 to 12 per cent. of the total number, as is indicated by the figures which have already been given. Considerably more than one-half of the fishing population of the United States belongs to the Atlantic coast north of the capes of Delaware; of this number at least four-fifths are of English descent. They are by far the most interesting of our fishermen, since to their number belong the 20,000 or more men who may properly be designated the "sailor fishermen" of the United States,—the crews of the trim and enterprising vessels of the sea-going fishing fleet which ought to be the chief pride of

the American marine, and which is of such importance to our country as a training school for mariners, and as a medium through which one of the most valuable food resources of the continent is made available.

Prof. Goode referred to the mental and physical traits of the New England fishermen, their enterprise as shown in their readiness to adopt improved methods, their intelligence and public spirit. He spoke also of the education of the young fishermen, and the injury to good seamanship resulting from the custom of deferring the shipment of boys who formerly entered the business at the age of ten or twelve but who now remain on shore until they are fifteen or sixteen, and have had their perceptive faculties dulled by school training. Reference was made to the morality of the fishermen, the strict observance of the Sabbath to be met with among large classes of them, and the entire absence of ardent spirits on the fishing vessels. The character of their favorite books and newspapers, their amusements, their dialect and their superstitions were discussed. The chief diseases were noted to be dyspepsia and rheumatism. They are, as a rule, long lived, though the fishing population of large ports like Gloucester is decimated by disaster every year or two. The financial profits vary from \$1,000 to \$100 a year for each man, though sometimes a year's work results solely in an embarrassing burden of debts.

Prof. Mason expressed surprise at the statement made in the paper that the quality of American fishermen was deteriorating, in consequence of the superior educational facilities now enjoyed by the people. Prof. Goode accounted for it by the fact that education tended to deter bright boys from engaging in the business. The paper was further discussed by Dr. Morgan and others.

The second paper was by Major A. M. Hancock, of Maryland, on PREHISTORIC DISCOVERIES IN THE SOUTH OF SPAIN, where he was, for nearly seventeen years, United States consul.

The paper was delivered extemporaneously and illustrated by

maps, charts, and specimens. From a stenographic report the following abstract of the paper has been prepared :

The speaker described certain remarkable prehistoric remains which had been discovered while he was President of the *Pre-historic Society of the South of Spain*.

The first of these were found in a cave which was called the "Cave of the Bats," situated in the neighborhood of Albuñal, between Malaga and Almeria. It is called by that name because when first discovered it was literally filled with bat-guano. This was cleared away, and within were found, first, three skeletons in a sitting posture, the center one of which, that of a woman, having still remaining upon her skull a crown, weighing about $1\frac{1}{2}$ ounces of pure gold, 24 carats fine. She also had on, at the time of her death, a tunic, made of the well known esparto grass, very finely made. The other two were dressed pretty much the same, except that the tunics were made of coarser but sound material.

Farther in were found three more skeletons, one of which had the skull crushed between two stones, indicating, as he supposed, that the man had been executed. Beside him was found an esparto bag containing food carbonized by the atmosphere, and another containing hatchets and arrow-heads, specimens of which were exhibited, and of which he was supposed to be a maker.

At another point in this cave were found twelve skeletons arranged in a semi-circle, one of which occupying a central position was that of a woman having on a hide tunic laced up under the left arm. Each of these skeletons was in a fair state of preservation when found, but on exposure to the air they crumbled to dust.

Still farther internally fifty skeletons were found together, whose character and surroundings indicated that they were warriors. Lying all about them were many stone arrow-heads.

The speaker next described a stone temple, as he called it, being in the nature of an enormous dolmen, or cromlech, situated on the outskirts of the city of Antequera, and known as La Cueva de Mengal.

It is built on an artificial mound, of which there are two others. The structure described is 90 feet long, 14 feet wide at its western end, 18 feet in the center, and at the beginning of the vestibule about 7 feet wide, and about 10 feet high. The five covering stones weigh 450 tons. From the western end to the entrance of the vestibule it is 59 feet, and the vestibule is 31 feet in length.

Immediately in front of this temple is a mountain, called La Peña de los Enamorados, presenting at its summit a perfect figure of the human profile. As all other prehistoric caves of which he had any knowledge faced directly east, his theory of this was that it was not intended as a burial mound, as some supposed, but as a temple of worship, the officiating priest having La Peña de los Enamorados directly in his view.

The stone that covers the western end was estimated to weigh 160 tons. The nearest point from which these huge stones could have been obtained was 18 miles distant, with two rivers intervening.

The speaker also described a plain in the vicinity of Antequera, which is strewn with oyster shells. This plain or basin is about 1,900 hundred feet above the level of the sea. It would seem to have once been inhabited by prehistoric man who lived principally upon oysters and left their shells scattered over the ground.

At the close of his remarks Major Hancock presented the Society with a copy of a work descriptive of these and other archæological remains in the south of Spain entitled *Antiquedades Prehistoricas de Andalucia*, etc., Por Don Manuel de Góngora y Martinez. Madrid, 1868; 4to., pp. 158, with 149 figures, plates, and map; also two charts illustrating the profile and form of a dolmen described by Major Hancock, in which were found numerous human and other remains. These were accompanied by two worked flints from the cave and portion of a fossil oyster shell found on the surface of the plain, the latter appearing to consist chiefly of such shells, and having a height of 1,900 feet above sea level.

FORTY-THIRD REGULAR MEETING, October 4, 1881.

Rev. J. Owen Dorsey read a translation, made by himself, of an Omaha myth, entitled THE ORPHAN AND THE BUFFALO WOMAN. The following is an abstract :

Wahandhishige, the orphan, lived with his married sister, who was unkind to him. She never allowed him to eat any choice piece of meat, although her husband was a good hunter and brought plenty of game to the lodge. A buffalo woman visited the orphan when he was alone in the lodge, and made him eat some of the meat, restoring the piece from which it had been cut to its proper shape. This occurrence was repeated on three other days. Then the orphan followed the woman, overtaking her by evening at a white lodge on the prairie. While he slept the woman and lodge disappeared, and when he awoke he was lying on the grass. This happened on four days in succession. The myth then gives: 1st, The adventures of the woman, after parting with the orphan; 2d, The adventures of the orphan when in pursuit of the woman. In the first part is told the birth of her child, the white calf, (some say two calves;) his abduction by Ishtinike, the deceiver; his escape and return to his mother. Then follow the adventures of the orphan, showing how he overcame great difficulties that were destined to hinder his pursuit; how he crossed the great water, a deep canon, a tract of land, covered with briers and thorns; and how he went even to the upper world. Returning from the upper world he killed a number of the buffaloes; then he took his family to his old home. He discovered himself to his unkind sister and her husband, who had been unfortunate since the departure of the orphan. They received him and his family, and were rewarded by the return of game and consequent prosperity. The sister profited by experience, and was ever thereafter kind to her brother and his family.

The President of the Society read a paper on the MYTHS OF THE WINTUNS OF THE SACRAMENTO VALLEY.¹

¹This paper will be published in a much enlarged form in the "Annual Report of the Bureau of Ethnology."

In reply to an inquiry by Prof. Mason, Major Powell enumerated certain tribes of Indians that bury their dead by clans.

Mr. Hinman stated that this was not the case with the Dakotas.

Prof. Mason remarked that he had discovered in the myths related by Mr. Dorsey and Major Powell a material substratum to the mythical; that is, the myth seemed to account for the origin of inexplicable phenomena, by means of things no longer regarded as mythical.

Major Powell replied that this idea proceeded from a misunderstanding of the nature of Indian philosophy. With savages the production of effects at a distance from the cause does not require the intervention of a material medium. He reviewed the progress of the conception of wind through the different grades of social progress, as seen in the Norse, the Greek, and the later mythologies.

In reply to a question by Mr. Guss, he stated that he presumed the order in which the different animals were slain by the boy prodigy as he grew older correctly represented the degrees of difficultness with which the Indians regard the capture of these animals; the eagle, which was the last named, being taken by them only with great skill.

FORTY-FOURTH REGULAR MEETING, October 18, 1881.

Mr. S. D. Hinman read a paper on THE STONE GOD, OR ORACLE, OF THE PUTETEMNI BAND OF HUNKPATI DAKOTAS.

This oracle was seen by him while on an expedition with some Dakotan Indians across the James River Valley, in Dakota Territory. A Hunkpati man of the party gave the history of the stone, and an account of its miraculous movement from the Sacred Hill to the old dirt lodge village. This story Mr. Hinman related. He then explained what the Dakota stone god is and the worship paid to it. It was then shown from old papers preserved by the Massachusetts Historical Society that this worship was probably

identical in many Indian tribes. The Oneida stone was described as an illustration, and others were given which were formerly well-known in New England and New York.

The paper closed with a description of the standing rock in Dakota Territory, and the legend of that rock was related.

Mr. Guss spoke of the Oneida stone. He said that the word Oneida meant people of the red granite stone. It was the tradition that the Oneidas came out of the ground on that spot, though they believed in a sort of transmigration of souls. He also mentioned similar myths among Iroquois tribes clustering about the idea of a standing stone, and remarked that the words Juniata and Oneida were only corruptions of the same word.

Col. Mallery then read a paper on the DANGERS OF SYMBOLIC INTERPRETATION.¹ The following is an abstract of the paper:

Few writers on the pictographs, customs, or religious rites of the North American Indians have successfully resisted the temptation to connect them symbolically with those of certain peoples of the Eastern Hemisphere. The Spanish priests found among the Mexicans many delineations of the cross and serpent which satisfactorily proved to them the former introduction of christianity; Adair delighted to show the existence of Israelite ceremonials among the Muskoki; and Lafiteau traced the customs of the Iroquois to the pre-Hellenic inhabitants of Greece. Schoolcraft is full of symbols of a more abstract and supposed original character, such as *power*, *deity*, and *prophecy*. The frequent recurrence on this continent of the number *four* has become a new mine of treasure to writers infatuated with the mysticism of numbers. Alphabets, Runic, Akkad, Phœnician, and of all other imaginable origins, have been distorted from the Dighton Rock and multitudinous later precious "finds," while other inscriptions are photographed and lectured upon to exhibit the profound knowledge by some race supposed sometime to have existed in North America, in the arbitrary

¹ This paper was in part repeated under the title "Spurious Symbolism," in "International Review," Vol. XII, pp. 45-52.

constellations of astronomy and zodiacal signs now in current use. Our learned associations are invaded by monomaniacs, harmless, save for their occupation of valuable time, who show that every ancient cisatlantic object means something different from what is obvious to common sense, and their researches are gratified by frauds and forgeries, sometimes originating in mischief and sometimes in desire for gain.

The speaker then gave, at some length, the account of an attempt, fortunately not successful, of an apparently honest enthusiast to compromise the American Association for the Advancement of Science at its late session in Cincinnati.

Such fanciful and misleading theories and statements require a note of warning.

In examining the subject it seems proper to establish the precise relation between signs and symbols. Those terms are often used interchangeably, but with liability to misconstruction, as most persons, whether with right or wrong lexical definition, ascribe to symbols an occult and mystic significance.

A *sign* is the most general—that by which anything is made known or represented. A symbol has been defined as the sign of something moral or intellectual by the images or properties of natural objects; but that would include an emblem in which, by a figure of thought, corporeal objects stand for moral and intellectual qualities, and a symbol should be distinguished as that species of emblem which is a constituted sign among men of such qualities.

An alphabet, or scheme of signs by which a language is written, is not in its essence symbolical, and the Semitic scheme, the parent, notwithstanding the wide diversity of languages, of nearly all the graphic systems prevailing in the world, had not even its origin in symbols. The first step toward writing was the rude pictorial representation of objects without indication of any accessories, followed by application of symbolic meaning to some of the figures most used and known, and some pictures, more and more abbreviated, also gradually became conventional signs, which, in time,

were made to stand for sounds either syllabic or alphabetic. So the growth of symbols and phonetic characters, nearly related but quite distinct, proceeded simultaneously with increasing divarication. Most ancient writing was, indeed, hieroglyphic; that is, a record made by one ignorant of, or unwilling to use, a phonetic method, but hieroglyphs dealt more in ideographic signs, representing objects by simply imitating their forms, than in those purely symbolic, which indicated their nature or properties.

It is true that the letters of an alphabet may, like an infinity of other objects, be adopted as symbols. In the science of algebra it was convenient to represent known quantities by the first, and unknown by the concluding letters of our alphabet, so that, in time, *A* was considered a symbol of the fixed, or certain, and *X* of the doubtful, or mutable. This is not criticised while the application is limited and its wholly arbitrary nature borne in mind; but suppose some ardent algebraist and symbolist should insist that the significance of these symbols was intrinsic to the letters, or even suggested from their form: "Observe," he might say, "the very frame of *A*, a pyramid standing on its base, the embodiment of solidity, still further strengthened by a cross brace! of course it must signify the fixed and certain! And *X*, two bars only united at a middle point, top, base and sides nearly equal, and thus liable to be deflected readily to any position, perhaps an image of the spokes of a wheel never at rest, surely it is the vague, the unknown!" This *reductio ad absurdum* is not more obvious than many cases where symbols are manufactured and misapplied by enthusiasts.

Volumes have been devoted to the symbolism in the arbitrary signs used in arithmetical notation. The decimal system prevailed only because the human race rejoices in ten figures for ready objective exhibit, and not some other digital allowance, and after the expedients of notches in wood, bags of stones, strings of shells, and the like, when the Hebrews and Greeks acquired the notion of representing number by characters, they employed the letters of the alphabets already in their possession. Our more convenient

notation came through the Arabs, who, about the 10th century, obtained it from Hindostan (where, it is asserted, the figures were anciently the initial letters of the Sanscrit names for the digits), and has rendered easy those calculations and deductions which display many curious properties of, and relations between, numbers. But it behooves to distinguish the ideas elucidated through mathematical experiments from the mere signs or value of the notation—that is, the apparatus—so that the latter may not claim a retro-active significance.

Many of the curious and often beautiful results from combination of numbers have, on close examination, no more intrinsic import than the also curious and beautiful reflections produced by turning a kaleidoscope, and dependent on much the same principles of mathematical relations between quantities and magnitudes.

Devotees of symbolism, in their undue zealotry, seem to have pried about with a *number* in their hands, determined to fit it into some object, like trying a stray key to all accessible locks. A not very ancient work set forth, among other attributes, of the number 7, with much flourish, that there are *seven* planets and *seven* metals, which, indeed, was the limit then known, but we now recognize at least fifty metals, and the planets have also increased on acquaintance apart from the asteroids, which, at the present rate of discovery, may soon swell the list to two hundred.

Belief in the mysticism of numbers has often retarded scientific research. Huygens, in 1655, discovered a satellite of Saturn. He then stopped observations because the six planets (Saturn then being the oldest known planet) and the six satellites, one of the earth, four of Jupiter, and that one of Saturn made the *perfect number* of twelve. So he asserted solemnly that nothing more of planetary system was left to be discovered. This blunder warns us not to build symbols needlessly on the shifting sands of ignorance, to be demolished by the advancing ocean-wave of science.

Symbols that have once reigned with perfect title may degenerate into petty signs. The chevron, an honorable ordinary in heraldry,

representing two rafters of a house united at the top, was originally bestowed on the founder of a house or family thereafter entitled to bear arms, and in that use was a perfect symbol. When the modern army uniform was planned the facility of forming an obtuse angle by two strips of cloth led to the selection, from among all the heraldic blazonry, of the chevron to mark the sleeves of non-commissioned officers; so that, while retaining both its name and form, its purport wholly disappeared.

The initial character of medical prescriptions met a fate still more humiliating; once portraying the extended wings of Jove's eagle and used as a prayer to the king of gods for his aid to the action of the remedy, its very shape was corrupted until, resembling the letter R with a flourish, [R] it is vulgarly called an abbreviation of the word "Recipe." So, though once a sublime symbol, it has ceased to be even a respectable sign.

The barber's pole, in the middle of its history, *was*, perhaps, a symbol, having started as an honest, though prosaic sign, and ends, in this country at least, as one neither appropriate nor sensible. The bloody band used by barber surgeons in their phlebotomy, wrapped, for convenience, spirally around a supporting rod, was, in the last century, still found in some Old World nooks, and when that utensil was exhibited in front of the shop it signified "bleeding done here," just as the old boot the cobbler hangs over his door is the advertisement of his humble calling. When the red band was painted on the contrasting white ground of a pole, and the tonsor only drew blood by accident instead of by profession, the device might claim some symbolic dignity, but the blue stripe was lately added in the United States; so that, in the combination of colors now shown, a fanciful physiologist may detect the distinction between venous and arterial blood, and the more poetic and religious mind may be exalted to suggestions embracing the ark of the covenant. Now, the change, under my personal observation, has occurred from the enterprise of some patriotic barbers who added blue to the red and white so as to include all the national colors,

and the fashion, once set to the imitative race which mainly does our shaving, has lately advanced another step, so that their newest poles show the blue in a union, with the proper arrangement of stars, and the red and white stripes extending straight instead of spirally, becoming nothing more nor less than a wooden United States flag of clumsy shape.

In the examination of pictographs and of sign languages as nearly connected with them, it is important to form a still more explicit distinction between signs proper and symbols. All characters in Indian picture writing have been loosely styled symbols, and as there is no logical distinction between the characters impressed with enduring form and when merely outlined in the ambient air, all Indian gestures, motions, and attitudes might with equal appropriateness be called symbolic. While, however, all symbols come under the generic head of signs, very few signs are in accurate classification symbols. Symbols are less obvious and more artificial than mere signs, require convention, are not only abstract, but metaphysical, and often need explanation from history, religion, and customs. They do not depict but suggest subjects; do not speak directly through the eye to the intelligence, but presuppose in the mind knowledge of an event or fact which the sign recalls. The symbols of the ark, dove, olive branch, and rainbow would be wholly meaningless to people unfamiliar with the Mosaic or some similar cosmology, as would be the cross and the crescent to those ignorant of history. The last named objects appeared in the class of *emblems* when used in designating the conflicting powers of Christendom and Islamism. Emblems do not necessarily require any analogy between the objects representing, and the objects or qualities represented, but may arise from pure accident. After a scurrilous jest the beggar's wallet became the emblem of the confederated nobles, the Gueux, of the Netherlands; and a sling, in the early minority of Louis XIV., was adopted by the Frondeur opponents of Mazarin, from the refrain of a song. The portraiture of a fish, used, especially by the early Christians, for the name and

title of Jesus Christ was still more accidental, being, in the Greek word *ἰχθύς*, an acrostic composed of the initials of the several Greek words signifying that name and title. The origin being unknown to persons whose religious enthusiasm was as usual in direct proportion to their ignorance, they expended much rhetoric to prove that there was some true symbolic relation between an actual fish and the Saviour of men. Apart from this misapplication, the fish undoubtedly became an emblem of Christ and of Christianity, appearing frequently on the Roman catacombs, and at one time it was used hermeneutically.

The several tribal signs for the Sioux, Arapaho, Cheyenne, &c., are their emblems precisely as the star-spangled flag is that of the United States, but there is nothing symbolic in any of them. So the signs for individual chiefs, when not merely translations of their names, are emblematic of their family totems or personal distinctions, and are no more symbols than are the distinctive shoulder-straps of army officers. The *crux ansata* and the circle formed by a snake biting its tail are symbols, but *consensus* as well as invention was necessary for their establishment, and the Indians have produced nothing so esoteric, nothing which they intended for hermeneutic as distinct from descriptive or mnemonic purposes. Both picture writing and sign language can undoubtedly be and are employed to express highly metaphysical ideas, but to do that in a symbolic system requires a development of the mode of expression consequent upon a similar development of the mental idiocracy of the gesturers far beyond any yet found among historic tribes north of Mexico. A very few of their signs may at first appear to be symbolic, yet even those on closer examination will probably be relegated to the class of emblems.

The point urged is that while many signs can be used as emblems and both signs and emblems can be converted by convention into symbols or be explained as such by perverted ingenuity, it is futile to seek for that form of psychologic exuberance in the stage of development attained by the tribes now under consideration. All

predetermination to interpret either their signs or their pictographs on the principles of symbolism as understood or pretended to be understood by its admirers, and as are sometimes properly applied to Egyptian hieroglyphs, results in mooning mysticism. This was shown by a correspondent who enthusiastically lauded the *Dakota Calendar* (which is a mere figuration of successive occurrences in the history of the people), as a numerical exposition of the great doctrines of the Sun religion in the equations of time, and proved to his own satisfaction that our Indians preserved hermeneutically the lost geometric cultus of pre-Cushite scientists. He might as well have claimed it to be the tabulated dynasties of pre-Adamate kings. The chart was exhibited with the true interpretation compared with the symbolic read from the letter.

Another exhibition of this vicious practice was recently made in the interpretation of an inscribed stone alleged to have been unearthed near Zanesville, Ohio, an engraving of which was exhibited. Two of the characters were supposed, in liberal exercise of the imagination, to represent the Λ and Ω of the Greek alphabet. At the comparatively late date when the arbitrary arrangement of the letters of that alphabet had become fixed, the initial and concluding letters might readily have been used to represent respectfully the beginning and the end of any series or number of things, and this figure of speech was employed in the book of Revelations. In the attempted interpretation of the inscription mentioned, which was hawked about to many scientific bodies, and published over the whole country, the supposed alpha and omega were assumed to constitute a universal as well as sacred symbol for the everlasting Creator. The usual *menu* of Roman feasts, commencing with eggs and ending with apples, was also commonly known at the time when the book of Revelations was written, and the phrase "*ab ovo usque ad mala*" was as appropriate as "from alpha to omega" to express "from the beginning to the end." In deciphering the stone it would, therefore, be as correct in principle to take one of its oval and one of its round figures,

call them egg and apple, and make them the symbols of eternity. In fact, not depending wholly for significance upon the order of courses of a feast or the accident of alphabetical position, but having intrinsic characteristics in reference to the origin and fruition of life, the egg and apple translation would be more acceptable to the general judgment, and it is recommended to enthusiasts who insist on finding symbols where none exist.

Mr. Bigelow called attention to Fig. 71 of the chronological chart of the Sioux Indians used in illustrating the paper, and noted its resemblance to the ornamentations on Indian blankets.

Mr. Ward raised the question whether the letter, read by Col. Mallery, on the symbolic interpretation of this chart, might not have been intended as a burlesque.

Col. Mallery stated that it bore every mark of sincerity and genuineness.

Prof. Mason spoke of the growing prevalence of this school of symbolic interpretation, especially in Europe.

Mr. Ward inquired whether the recent attempts to explain the origin of the Arabic numerals as a modification of straight lines rested on any authentic basis.

Col. Mallery thought it did not.

FORTY-FIFTH REGULAR MEETING, November 1, 1881.

Dr. Edward M. Gallaudet, President of the National Deaf-Mute College, read a paper entitled *HOW SHALL THE DEAF BE EDUCATED?*¹ The following is an abstract of the paper:

A suitable classification is important to a proper consideration of the question.

The *class* should be spoken of as *the deaf*. The term deaf-mute should be applied to such only as are totally deaf and completely dumb.

¹ Published in full in the "International Review," Vol. XI (December, 1881,) pp. 503-516.

Besides this sub-class, there are the *speaking-deaf*, the *semi-speaking deaf*, the *speaking semi-deaf*, the *mute semi-deaf*, the *hearing-mute*, and the *hearing semi-mute*, these two last sub-classes being, usually, persons of feeble mental power.

With a class involving such essential differences among its sub-classes and orders, no single method can be expected to be successful.

The first requisite in the instruction of the deaf, as in all teaching, is the establishment of a ready and adequate means of communication between teacher and pupil.

The natural language of the deaf, is beyond all question, the language of signs and gestures. But experiment has proved that many deaf persons, including not a few congenitally deaf, may be taught to speak, orally, and to understand what is said by others, from the movement of their vocal organs.

The value of the power of speech is so great, that many have insisted that *all* deaf persons can, and must be taught to speak.

To suppose that all can be taught to speak well is an error.

Many deaf persons are lacking in imitative power, in their power over the muscles of their vocal organs, in their power of vision, and in other particulars, which make it impossible for them to attain success in speech.

For them it is the wise course to forego all effort to impart speech, and give them education through the use of signs, the manual alphabet, and writing.

Experience has abundantly proven that deaf persons so educated, may lead happy and useful lives, mingling readily with hearing and speaking people.

It is recommended that in all cases where success seems probable attempts be made to teach the deaf to speak; that where it is practicable special schools for oral teaching should be maintained; that in all institutions for the education of the deaf articulation should receive attention; that the manual alphabet should be used in all schools for the deaf, and that signs should be made use of

even in oral schools, especially with advanced pupils, as a means of conveying instruction in the form of lectures.

Col. Mallery spoke of the capability of sign language to express abstract and abstruse ideas, and remarked that Mr. Edward B. Tylor had maintained that it was incapable of such expression, while Max Müller claimed that these ideas were all derived from sensuous ones. Mr. Tylor had given as examples of conceptions not capable of being conveyed by signs, those of *momentum* and *plurality*. He asked how this was.

President Gallaudet replied that for the conveyance of abstract ideas, a certain amount of explanation in simpler terms was usually necessary, but to say that abstract ideas, such as those of momentum and plurality, could not be conveyed by signs, would simply provoke a smile from any practical teacher of the deaf and dumb.

Dr. Fletcher inquired what proportion of deaf-mutes are found capable of acquiring the power of oral speech.

President Gallaudet replied that this differed with the language, the Italian being easiest to acquire, and that between one-third and one-half the pupils could learn to speak it. With the English the statistics did not cover a sufficiently long period to deduce the proportion accurately, but he thought it would be about one-third. In reply to the further question relative to the children of the deaf and dumb lady whose letter he had read, he stated that they were all normal, and remarked upon the small tendency of deafness to descend to the offspring even of parents who are both afflicted.

Dr. Hoffman mentioned two deaf Indian children whom he knew, and who seemed incapable of acquiring the sign language of the tribe.

President Gallaudet could explain it only on the assumption that they were mentally deficient.

Prof. Mason asked how far are we acquainted with the history of the movement for the education of the deaf in different nations, as Chinese, Japanese, etc.

Col. Mallery said they were classed by Constantine with the insane.

President Gallaudet stated that no extended history of the matter for the whole world existed. He had once undertaken such a work but had been compelled by other duties to suspend it. He said that records on the subject, in Europe, date back four or five centuries, and schools had existed in France, Germany, and Italy for one hundred and fifty years. He was certain no such institutions existed in China. Japan has two small schools. He was invited, in 1867, to go to China and establish a school, and had accepted the invitation, when the rebellion broke out there and put an end to the scheme.

Dr. Welling desired to learn in what sense deaf-mutes are capable of receiving and expressing ideas of the higher class; whether deafness was a bar to the intellectual acquirements made by other persons.

President Gallaudet replied that it interposes no obstacle to mental development, except that connected with acoustics. He had even questioned whether it did not tend to quicken thought by the forced absence it imposes of the multiform distractions which enter other people's minds through the ear.

In reply to Mr. Bigelow's question, whether the mere jar produced by some sounds did not furnish a sort of substitute for hearing in some cases, he said that this was simply feeling and not hearing, and that deaf people were able to make some use of it.

Mr. Gilbert inquired whether there was a universal system of signs, so that deaf-mutes of all nationalities could understand one another.

President Gallaudet said that this was the nature of the true sign language, but that besides this, special arbitrary signs were used by different schools; there was also an alphabetic language, and this he regarded as really the most complete system. He spoke of lip-reading, and said that Prof. Bell was now preparing a list of words of different meaning and spelling, but requiring the same position of the lips (*homophemes*).

Dr. Welling asked if sign language did not convey ideas to deaf persons more directly and impressively than oral language.

President Gallaudet said that it certainly did, but only certain kinds of ideas. He spoke of the superiority of the sign language in large classes or where a great number of persons are addressed.

Dr. Hoffman mentioned the meeting of the Ute Indians with the deaf-mutes at the National Deaf-Mute College, and said that they were able to carry on a free interchange of ideas, showing that the syntax was identical.

Dr. Fletcher inquired whether the presence of a beard or moustache was not a serious obstacle to lip-reading. President Gallaudet replied that it was a part of the regular course of instruction to accustom the pupil to the beard and mustache, and some became so expert that they could understand even when the hand was held over the mouth and lips, by observing the peculiar action of the other parts of the face, the eyes, head, etc.

Mr. Ward asked if any data existed for determining whether educated deaf-mutes, as a class, had contributed their share to the intellectual work of the world, and mentioned the case of Mr. Leo Lesquereux, the well-known vegetable paleontologist. He said that, considering how small the class is, it would not, of course, require a very great absolute number to constitute its quota.

President Gallaudet thought that it had done so, and instanced a number of deaf persons, of greater or less distinction in one way or another, among them John Kitto, Charlotte Elizabeth, Ferd. Berthier, and two brothers Moore, of Hoboken, embracing various professions, authorship, and art. He further remarked that, of the graduates from the National Deaf-Mute College, one had become a successful patent lawyer and another an editor.

Mr. Henry Baker spoke of Mr. Parkinson, the patent lawyer referred to, testified to his intelligence and business ability, and said that the degree of master of arts had been conferred upon him.

Mr. Ward said he thought the facts showed that the art of communicating ideas was a necessary result of the possession of ideas

to communicate, and depended less than was commonly supposed upon the possession of the faculty of oral speech. He expressed his belief that if the human race, all other things being as they are, had been destitute of that faculty they would have nevertheless found means of carrying on the various functions of civilized society very nearly the same as they now do.

FORTY-SIXTH REGULAR MEETING, November 15, 1881.

Mr. R. L. Packard read a paper reciting A NAVAJO MYTH. The following is an epitome of the myth :

The story in brief is that the Navajos first appeared as certain animals, in a world under the earth we inhabit. There they lived a long time, under the rule of twelve chiefs, one of whom was the head chief. In consequence of the discovery of the infidelity of the wife of this chief, an absolute separation of the sexes throughout the tribe was effected, by the males crossing a large river, which flowed near the camp. The two sexes lived apart four years, at the end of which time many females had died, and the rest were threatened with starvation, so that a reunion of the males and females was made necessary. After this had been effected a water monster, which lived in the great water near which the people were camped, was robbed of its young by Coyote; the evening of the same day the water began to rise and caused a flood, which drove all the people up to a high mountain; and the water still rising, they planted a reed on the top of the mountain and fled to its interior for safety. This reed grew rapidly and carried them to the upper earth, which Badger was sent forth to explore. His report was that the upper earth was covered by a sea, like the one which had driven the people up the mountain below; and that there were four swans at the four corners, viz., the north, east, south, and west corners of this sea, with whom he had had a combat; he and Cicada vanquished the swans and the people came to the upper earth, through the hole he had made, and took possession of the

whole region ; their wise men and medicine men (priests) made the sun, moon, and stars (for it was as yet dark) after four days experiment ; and one of the medicine men went with the sun to regulate its movements and he was never afterwards seen, but continues with the sun to this day.

A similar wise or magic man, but of the *Zuñis*, went with the moon.

After this they planted the seeds of trees and vegetation in general, which they had brought up with them.

After increasing to a great number, a conflagration destroyed all but a few of the people ; and after this remnant had again increased to a large number, certain monstrous animals and a giant in human form came and devoured all but one male and one female. This female found a female child at the foot of a rainbow one day, which she took home and raised as her daughter. In due time this child, having grown to maturity, became the mother of two male children by the sun. These children were infants in arms four days ; after which they were able to run about four more days ; and at the end of this period they were men grown.

On reaching manhood they asked their mother about their father ; and being by her instructed, set off on a long journey to visit their father, whose house they found far away in the East ; after an interview with him they returned, journeying with their father in his daily course in the heavens, to their own country ; and by his assistance, killed the various monsters which had devoured their people.

Under instructions from their father they consulted their mother about re-peopling the earth ; and she, by magic, made one male and one female in human shape ; and this pair was the source of nearly all the *Navajos*.

This woman went then to a great ocean in the West, where she still lives ; and she and the sun-man are the deities which are revered by the *Navajos*.

The story is localized by the introduction of the names of moun-

tains, etc., in the Navajo country, where the events are supposed to have occurred, and was obtained from a half-breed Navajo, aided by an old man of the tribe.

Mr. Gatschet remarked that the myth seemed to be a compound of numerous traditional legends, and showed how a number of the events recited might be allégorically interpreted; *e. g.*, the separation of the men from the women probably represented the division of day and night. The giant he thought was emblematic of the sun.

Prof. Mason expressed surprise that no connection could be traced between these Navajo myths and the *Tinnée* myths, notwithstanding the certainty that the Navajos had migrated from British America within comparatively recent times, and spoke of the rapidity with which myths grow.

Dr. Hoffman asked if certain parts had not been omitted from the myth as read.

Mr. Packard replied that he had tried to embrace all the essential parts.

Col. Mallery spoke of the analogy between principal occurrences described in the Navajo myth with those contained in the myths of other peoples; as for example, that of the separation of the sexes with the story of the Amazons; the rising of the waters with the wide-spread tradition of a deluge; and the occupation of the reed with the fable of Jack and the bean-stalk. He also called attention to the usual predominance of the number four.

Prof. J. Howard Gore then presented a communication on the REGULATIVE SYSTEM OF THE ZUÑIS. The following is an abstract:

Zuñi is situated in the western part of New Mexico, 12 miles from Arizona and about 250 miles southwest of Santa Fé. It is built of adobe; the houses are contiguous, and in some places cover the irregular streets, thus uniting the whole town into three single buildings.

The subsistence of the people is derived from herds of sheep and goats and from the soil. The minor crops are grown near the

town, while their corn fields are at Pescado, and the wheat is raised at Mutria. The men plant and cultivate the crops and the women gather, garner, and prepare the grain for use.

The women receive more attention here than is usual among Indians.●

The clan organization is for a triple purpose: to determine the line of marriage, for social amusement, and for religious observances. Descent is in the female line. Monogamy exists. Divorces are readily obtained, and are unattended by reproach, but are by no means common.

In order to be a member of the religious order—the Priests of the Bow—it is necessary to secure a scalp and undergo a number of ordeals. The election of a person into this order is confirmed by a great feast. All persons charged with murder are tried by this order. The accused conducts his own case, and a member is appointed to manage the prosecution. The decision is reached in secret council and the verdict made known afterwards. If guilty the criminal is executed privately.

Property is exclusively individual, and can be disposed of by the owner without consulting any one. Children may own property—even land. The property of a man dying intestate descends to his own children; but at any time prior to his death he may name his heirs. Seven caciques and one priestess constitute the supreme ecclesiastical tribunal, to whom all disputes and doubted points in religious or ceremonial matters are referred. A governor is the chief civil authority; he decides all minor questions himself, and only summons a council when the importance of the case demands it. In council no formal vote is taken; each person so expresses his opinion that the will of the majority is easily made known. Women have no voice in the councils.

Prof. Mason inquired whether differences of social standing regulated the occupancy of the Pueblo houses. Prof. Gore said that this did not seem to be the case. The Priest of the Sun lives

in the upper house, fourth terrace, while in other cases the wealthier classes usually live on the first story. The Governor's house was not by any means in the finest quarter of the town.

Mr. Bigelow asked whether the Zuñis make formal wills, and also how children are cared for.

Prof. Gore replied that wills were merely verbal, and that the wish of the deceased, however expressed, was conformed to whenever it was known. He was conversant with one contested will case. He also stated that in their anomalous marriage relations it did not always fall to the parents to take care of their own children.

Mr. Gatschet spoke of an annual festivity celebrated on Mt. Taylor, near Zuñi. He also inquired whether the usual division into gentes and phratries prevailed, and relative to the clans spoken of, whether they attempt to prove their origin.

Prof. Gore said there were fifteen clans among the Zuñis, which are organized chiefly for amusement and social intercourse, but were permanent and of very ancient origin. These have no connection with the usual division of the people into gentes. The gens merely determines the line of marriage; all must marry without their gentes. Descent was in the female line. He then spoke of the various ceremonies of the different clans, and gave a detailed account of a feast of the Corn-clan which he witnessed. He said that the music was sung in a language to a great extent unintelligible to living Zuñis, and which seemed to be a sort of sacred or classic tongue handed down from remote antiquity, which no one dared to change.

In reply to a question by Mr. Gilbert, he said this language somewhat resembled the present Zuñi language, but seemed to be a sacerdotal, archaic form of it.

Prof. Mason said that the Creeks and Choctaws also have an oratorical language having an elevated diction for state occasions.

FORTY-SEVENTH REGULAR MEETING, December 6, 1881.

Mr. M. B. W. Hough read a paper entitled A QUESTION IN CLASSIFICATION, of which the following is an abstract :

Classification is made possible by the persistence of inherited peculiarities, while it is rendered necessary by the diversities of such peculiarities which meet us daily in the street. It proceeds upon the present condition of affairs, but many considerations must enter any discussion of the subject.

Races of men are described by color, habitation, and by families. The last is the true method, but each observer has his own theory.

The proportionate diameter of the skull when measured laterally and longitudinally, and the contents of the brain in cubic inches are also favorite methods. Men have also been divided into two species by the position of the nostrils, whether close together or wide apart.

The angle between lines drawn from the forehead and the base of the brain, meeting at the front of the upper jaw, and the relative prominence of the jaws compared with the forehead and the chin, is used for the same purpose, and seem to be persistent. A division founded on the cross section of the hair seems incisive, but must, it would seem, yield to some, as yet, unrecognized distinction, which shall divide men into two families of races.

The diversities of the individuals who compose these classes, when each is taken as a whole, are manifold. One class delights in repose, is ruled by desires and acts from impulse ; the other delights in action, is ruled by ideas and acts from motive ; one is patient under restraint and satisfied with material comfort ; the other is ambitious of improvement and impatient of control. Anatomical differences are well known to specialists : one class has less muscular development and more protruding mouth ; it has also more flattened and scanty hair, accompanied by larger and more active perspiratory glands, whether these facts are related or not. The feet are less arched, arms longer, legs weaker, chests shallower,

and complexion darker ; and in culture, one class is behind the other.

There are difficulties in the application of so simple a theory, and the object of this paper is to ask where the line is to be drawn.

That there have been vast changes in existing climates and in the present distribution of land and water is unquestioned ; with corresponding effects, if not on the dispersal and variation of humanity, at least on all then existing organic life.

But we know that man has existed on the earth for a long period of time, and has moved from one place to another, as he does in the present and will do in the future, from the same motives. Whenever the Glacial Epoch occurred, as ice disappeared from Western Europe, man was there. And this is a significant fact, when connected with the other fact, that many northern forms of animals and plants are found in the further south, while no southern forms have invaded the north ; which opens space for momentous speculations as to the original location of man. If his northern origin is inconsistent with preconceived opinions, may he not, early in his life as a species, have been separated into two divisions, one being led north, the other south. If so, owing to permanent geographical causes, those who went south encountered less variety of condition than the other. Be this as it may, we see all over the world reminders of the migrations of men, and the emigrants, who usually occupy the more fertile and inviting regions, whenever comparison is possible, seem to have improved on their kindred who were left at home.

Is there such a division—one class embracing races of southern origin, the other those who have arisen in colder climates, and when found in southern latitudes are referred to the north ? The line of such division seems widened at its boundaries, but this widening is due to mixture of blood, which is shown in the blending and fusion of the characteristics of each class.

Here arises the difficulty in the application of the theory—certain people, by many qualities, belong to one class ; in others, as clearly

resemble the other. This is the case with the natives of Australia, who, resembling the one class in most if not all other things and in mental and social condition, have the wavy hair, full beard, and sharp sight of the other—where shall they be classed? They have no history or traditions, have never cultivated food-crops, clothed themselves, or had permanent dwellings, and it is questioned whether they knew the use of fire. Their appearance is analogous to many races of animals and plants found on islands, similar to those found on far off continents, yet specifically distinct, from which long isolation is inferred. This seems, by its fossils, to be true of the animals, and may well be true of the men of Australia. They are also the only people, apparently, of the southern class who have lived for ages in a temperate climate, and also who have hair but slightly curled. Some writers derive them from the Non-Aryan tribes of India, but as these are cultured—they all cultivate food-crops, have dwellings, clothe themselves, and use fire, arts that could not well be lost—and as emigrants usually take purpose and knowledge with them, it seems that any such recent resemblances would be more reasonably accounted for by reversing the course of the hypothetical migration.

Resemblances in language must be cautiously used in tracing relationship, as will be seen in the known origin of the so called Latin Nations of Europe.

While upon such separation as has been suggested, one portion went in one direction and the other in another, each would be soon modified by changed conditions, and would divide into clans, tribes, nations, and races; each class retaining the common as well as class characteristics. No special reference is made to American ethnology, for whether its pre-historic races are of single, or as is likely, of three-fold origin, they are all referred to northern sources.

The earlier relics of our kind show indices of the same grade of culture; so the farther back we go in the line of descent the more likenesses are found in people who seem widely separated in habita-

tion and apparently in blood. This fact explains many things which seem to be contradictory.

All this is general, but illustration and application are not far to seek. That the key to distinctions between classes, as well as races, is to be found in the bodily frame, and is now in the hands of those who study it, is, I believe, beyond doubt. Will somebody learn to use it?

Upon this communication Mr. Ward remarked that he had been struck by the analogy which it suggested between the geographical distribution of the human races and that of the lower animals and of plants. It seemed that in the one case as well as in the other the physically inferior types predominated in the southern hemisphere, and particularly in South America and Australia. Africa, however, constituted an exception, so far as animals and plants were concerned, and he raised the question whether this might not be due to the fact that geologically that continent properly belongs with Europe and Asia, with which it was connected until quite recent times, and whether the size of land areas did not have something to do with the degree of development made by the life inhabiting them; he also queried further whether this might not be in turn due to the relative length of time during which such development has been going on, presuming that it might have begun much earlier on the great northeastern continent. He spoke of the oft-repeated remark made by geologists and naturalists that America is really the Old World, and said that, in so far as life at least was concerned, the reverse must be the case, if, by the age of a fauna is meant the length of time it has been developing, as measured by the degree of advancement attained. From that point of view Australia would be the youngest continent, after which would follow South America, then North America, making the Old World in fact old zoologically and phytologically as well as anthropologically. That the human races, notwithstanding their superior migratory power, had retained certain of the same geographical peculiarities that characterize the lower forms of life, he thought quite probable.

Prof. Otis T. Mason then read a paper on THE DEFINITION OF ANTHROPOLOGY AND ITS SUB-DIVISIONS.¹

A running discussion followed upon the various terms adapted to the classification of the phenomena of anthropology.

FORTY-EIGHTH REGULAR MEETING, December 20, 1881.

Mr. Lester F. Ward read a paper entitled THE ANTHROPOCENTRIC THEORY.² The following is an abstract:

The aim of the paper was to bring together into something like logical order a few of the more salient facts which have been cited in favor of and against the belief in the existence of a beneficent agency in nature, more especially as operating in the direction of the welfare and advantage of man, considered as the end toward which the various processes of the universe have tended. These statements of fact were accompanied by such explanations, qualifications, and other comments as seemed necessary to secure their proper appreciation and their true bearing upon the problem.

The speaker called attention to the fact that writers of a teleological bias are continually advancing what they regard as proofs of intelligent design and benevolent provision in behalf of sentient beings, especially man. Until within quite a recent period all philosophy was strictly *anthropocentric*, and the lower grades of creatures capable of enjoyment and suffering were wholly ignored; but in later times a few of this school have expanded their scheme to embrace the animal world in general, rendering it *zoöcentric* instead of anthropocentric, although the existence of large orders of purely predatory creatures had proved a somewhat discouraging fact for their philosophy to assimilate.

Most of the examples that have been brought forward as establishing the operation of a designing intelligence and beneficent

¹ "American Naturalist," Vol. XVI., (January, 1882,) pp. 66-67.

² This paper will form part of Chapter VIII of the author's work "Dynamic Sociology," in press.

intent in the universe—optimistic facts, so called—can be classed under two general heads: They are either, 1, cases of natural or genetic adaptation; or, 2, they are mere coincidences.

Still a third class was, however, named in which the advantage is more apparent than real and becomes greatly reduced or disappears altogether on closer examination.

Under the first of these groups the following instances were enumerated:

1. A modern scientific writer had stated that in the case of the maternal instinct it was a mere accident that the course of action which the instinct prompts should be one that was conducive to the welfare of the offspring.

Against this view it was urged that this apparently fortuitous adaptation was clearly a genetic one and had been developed under the operation of the selective laws now generally recognized in biology.

2. The alleged excess of male over female births, supposed to be brought about for the purpose of supplying the loss of males incident to war and their more exposed mode of life, was questioned as a fact; the loss of males by violence being, probably, nearly compensated for by the greater delicacy of maternal functions; yet, if the supposed excess were proved, it might do no more than show that it was an advantage that it be so, which, on adaptation principles, would amount to accounting for the fact.

3. That the specific gravity of aquatic animals should almost exactly equal that of their medium was held to be a clear case of natural adaptation.

4. The allied fact that the bones of birds are hollow and communicate with the outer air was explained in the same manner.

5. The existence of the coal measures was cited as a favorite theme of optimists, and it was shown that it partook of the character partly of the first and partly of the second group. If it be true, as generally believed, that the process of their deposition had the effect to purify the atmosphere of its alleged excess of carbonic acid gas, then the fact must have constituted one of the conditions

to the development of higher forms of life, including human life, and as such it performs the office of an *efficient* and not a *final* cause. Since the close of the sixteenth century, when coal began to come into general use as fuel, it may have also produced a new effect upon the development of the race by greatly enhancing their comfort and consequent efficiency for action. In so far the correlation between the existence of the coal measures and the advancement of man has a causal relation and constitutes a case of adaptation; in any other sense it must be regarded as a pure coincidence.

6. Very similar to this case is that of the late appearance, geologically speaking, of the most important economic families of plants, and particularly the *Rosaceæ* and *Gramineæ*. These plants were shown to have been, equally with the coal measures, a condition to the existence of the higher forms of animal life which have been genetically adapted to them. Considered from any other point of view the co-existence is purely accidental.

Under the second group, or that of pure coincidences, the following cases were noted:

1. The alleged advantage to man of the spheroidal form of the earth in preventing irregularities in its motions, due to mountains and other inequalities of its surface, which the equatorial *meniscus* neutralizes. This, Kant, who first suggested it, proposed to explain on teleological principles, and he rebukes the attempt to explain it as due to the equilibrium necessarily produced by the formerly fluid mass of the rotating planet. But as the mechanical explanation is complete without the teleological one, and will apply to any case, even where it might be a disadvantage, the latter is at least unnecessary.

2. The fact that there is no relation of dependence between the dispersive and refractive powers of different substances, and which alone renders the construction of the achromatic lens possible. This was mentioned as a most fortunate case under the present head; but it was questioned whether this were not rather to have been

pected than the contrary, and whether admiration be really the proper attitude to maintain towards it.

3. It had been remarked by Brinkley "that if the velocity of light had been much less than it is astronomy would have been all but an impossible science." If it had been greater than it is, however, astronomical observation would have been in the same degree facilitated; and there was the same antecedent probability that it would be greater as less.

4. As a final case under this head was noted the circumstance that if the manufacture of alcohol had been so simple a process that the lowest races could have at all times obtained an unlimited amount of it, this would probably have effectually prevented the social development of the race, if it did not entirely extinguish it. It is a fortunate coincidence, therefore, that its production is only possible by races that have advanced far enough intellectually to be capable of foreseeing to some extent its evil effects and of exercising a certain control over their appetite for it.

Passing to the third group, or those instances in which the advantage is more apparent than real, only a single case was adduced as a type of the class.

This was the fact, so strenuously insisted upon by certain physicists, and notably Count Rumford, as a wise provision of nature in the interest of man, that water attains its greatest density at about $39\frac{1}{2}^{\circ}$ Fahrenheit, instead of at the actual freezing point. This view was based upon the supposition that if it were otherwise all bodies of water, even the ocean, would be frozen solid as often as the temperature fell to 32° . The fallacy of this reasoning has long been exposed, and it has been shown: first, that this property does not apply to the salt water of the ocean, which is about in the state from which the worst results of the theory would occur; second, that these results do not occur there, and would not in any liquid, but rather the opposite ones, viz., that bodies of water would never freeze over in temperate climates at all, since the superincumbent

mass of the water would prevent the cold from penetrating to the bottom, where alone congelation could take place if ice were heavier instead of lighter than water; and, third, that instead of water having been singled out as the only substance to be endowed with this property, it is now found that many others possess it, such as glass, bismuth, antimony, and even iron; so that independently of design the chances that water should possess it are about the same as that it should not, while the property itself is really of very doubtful advantage.

Upon an enumeration, therefore, of such cases only as seem to favor the anthropocentric theory it was maintained that the claim was a weak one. Unless the theory of adaptation is wholly rejected, the greater part of the illustrations fall under that head. A large share of the remainder are such as would be as likely to occur in the manner that they do, as otherwise, under the operation of the mathematical law of probabilities. The number of coincidences that can be noted is not greater than ought to be expected, or than are met with in other departments of human experience, while a few cases turn out, when fully understood, to be of doubtful advantage.

The speaker next proceeded to enumerate cases of the opposite general class, or such as seemed opposed to the doctrine of a special beneficent agency in the interest of man. This, he stated, was a much easier task than the preceding, which is itself a strong presumption against the optimistic view.

The illustrations adduced were grouped under three general heads, viz., 1, such as exhibit a condition generally unfavorable to life on the globe, either of men, animals, or plants—*anti-biocentric facts*;—2, such as negative, in one form or another, the assumption that the human race has been the special object of benevolent design—*anti-anthropocentric facts*;—and, 3, those in consequence of which social progress tends to defeat itself—*anti-sociocentric facts*.

A bare enumeration of the many cases cited is all that can be given in this abstract.

Under the first of those groups the following facts were set down :

1. That the longitudinal cohesion of the outer bark of many trees restricts their natural growth by binding the trunk too tightly and compressing the cells of the cambium layer. So obvious is this that horticulturists successfully relieve them by artificially slitting the bark.

2. That many plants bloom during a period of mild weather in autumn or winter, when there is no possibility that their fruit can reach maturity.

3. That the sting of many insects is so strongly barbed that it cannot be withdrawn from the body stung, but instead is extracted from that of the insect along with the viscera to which it is attached, resulting in the death of the latter. As only females are provided with stings the destruction of so many of that sex must be a disadvantage to the species.

4. That female opossums having only thirteen teats have been known to give birth to fifteen or sixteen young, and, as the continued life of each embryo depends upon its permanent attachment to a teat, the excess over the number of the latter must necessarily perish.

5. That moths, beetles, ephemeræ, and other insects possess a suicidal propensity to fly into a flame.

6. That birds and animals on newly discovered islands have no innate fear of man, and allow themselves to be readily caught, so that they are soon exterminated.

7. That animals attacked with rabies immediately acquire a disposition to bite others, whereby the deadly malady is multiplied.

8. That many imperfectly integrated annelids labor under a great disadvantage from being obliged to support a multitude of similar organs in different somites.

While none of the above facts are capable of a teleological, or optimistic explanation, it was shown in each case that from the point of view of evolution they may all be readily accounted for.

Under the second, or anthropocentric group proper, the following facts were co-ordinated :

Three cases, under the general head of "rudimentary organs," as they are called, which, while they perform no known functions, are at the same time the seats of dangerous diseases, viz. :

1. The tonsils, as the seat of tonsilitis.
2. The thyroid gland, the seat of the disease called goitre, or bronchocele.
3. The vermiform appendage of the intestines, in which two dangerous forms of disease are located.

Each of these has been traced back to a form in the lower animals, in which it was an active organ, which not only accounts for the existing vestige on true scientific grounds, but at the same time argues the descent of man from them. Yet this fails to relieve the optimist from the onus of proving a teleological advantage from them as they now exist.

4. Allied to these cases, but of less general renown, is that of the exposed condition of the lower extremity of the spinal cord, which, under certain circumstances, becomes the seat of a fatal malady known as rachidian meningitis. This condition, which is peculiar to man, is explained morphologically as a result of the assumption by man of the erect posture, in separating the sacral vertebræ and exposing the spinal cord.

The remaining cases cited under this head were taken from widely different fields :

5. That the ability to predict the weather is at once the most practically important and the most limited of scientific achievements.

6. That, as Laplace has shown, the elements of the solar system, from the human point of view, fall far short of the optimum.

7. That if, as many astronomers suppose, the moons of the larger planets are inhabited and derive their light and heat chiefly from their primaries, it is an ill-devised arrangement that in all cases they should always present one and the same side to them, leaving the other hemisphere in perpetual darkness.

8. That it would be much better for man if there could be about sixteen hours day to eight of night, corresponding to the normal requirements of activity and rest, and saving an average of four waking hours in darkness, with the accompanying cost of artificial illumination.

9. The misfortune was dwelt upon that all races should have been condemned to the use of either the quinary, decimal, or vigesimal system of notation, when either nine, twelve, or sixteen, but especially eight, would have constituted a basis so much superior in point of practical value. Genetically, it is easily explained as the result of man's possession of twenty digits.

10. That the human body should possess a specific gravity a trifle greater than that of water, coupled with the fact that man is not endowed with a natural instinct to swim; and this on a planet of whose superficial area two and four-fifths times as much is water as land, and which he is obliged to traverse in all directions. His supposed descent from purely terrestrial, or even partially arboreal anthropoid apes, would be a satisfactory genetic explanation of both these circumstances; but its admission would be no relief to the optimist from explaining them teleologically.

11. The brevity of human life was cited as an important barrier to intellectual progress. So large a portion of every one's lifetime is required to prepare for any useful work that little time is left for its accomplishment, and many are deterred from undertaking anything of real value. This, it was maintained, might as well have been otherwise, as there is nothing necessarily impossible in the limit of human life being two hundred years any more than in its being one hundred.

12. Living beings are so constituted that they multiply many times, often many hundred times, faster than their conditions would permit if the excess were not constantly kept down by the friction of the environment manifesting itself in a variety of ways. In the case of men, who form no exception to this law, disease, accident, violence, war, pestilence, and famine are among the

scourges that perform this office, the true cosmical nature of which is masked by our familiarity with the phenomena. The amount of suffering that would be saved if, instead of this method, that of diminished fertility or the destruction of unborn germs of life were adopted, is incalculable.

To these cases were added the following wholly disconnected but none the less apposite facts :

13. That the worst of all living enemies of mankind are too minute to be discovered by the highest-powered microscopes—the germs of disease.

14. That in temperate latitudes, where the bulk of the world's population occurs, northerly winds predominate in winter and southerly in summer, thus exaggerating the extremes of heat and cold.

15. That in mountainous regions the rainfall is chiefly on the tops of the mountains where it is not needed, leaving the otherwise fertile valleys and plains arid and parched.

16. That the most useful as well as the most beautiful objects in nature are usually the most rare.

17. That, whereas pleasures are usually moderate and brief, pains are often intense and protracted.

Under the last of the three general classes of anti-optimistic facts specified above, viz., the anti-sociocentric, or anti-progressive group, it was shown :

1. That social progress is rhythmical, and that its alternate flows and ebbs occasion incalculable waste, from the circumstance that only a part of what is gained by the flood-tide is retained after the ebb-tide is over.

2. That the study of phenomena has always had to be commenced from the top, and that the superficial view must be taken before the fundamental view can be gained ; so that the work of intellectual progress has consisted in the removal, not merely of ignorance, but of error.

3. That moral and social science, the most practically important

branches of knowledge, labor under difficulties from which all other sciences are exempt, since every attempt to analyze the phenomena of human action and social life into their simpler elements—a process essential to the study of any science—conflicts with received opinions and shocks a morbid sense which claims a preternatural character for the human race.

4. That the labor performed in the interest of social progress is unremunerative, and must usually be performed in the face of strenuous opposition ; which is alone sufficient to deter most men, however capable, from undertaking it.

5. That true merit is generally content to remain in obscurity, while the volatile elements of society thrust themselves into undue prominence and exert a greatly disproportionate influence.

6. That the mass of mankind wholly misconceive their own interests, and are generally found siding with the party that seeks to despoil them of their most valuable rights and liberties.

7. That the past tendency of the human intellect has been to ignore realities and waste its energies on empty speculations about transcendental questions.

8. That, while men have always had the most need, they have, at the same time, manifested the least disposition to exercise their intellectual faculties.

9. That in the present state of scientific progress the discovery of truth is rapidly distancing popular intelligence, so that it is impossible to assimilate the knowledge brought forth.

And finally :

10. That each and all of the many errors which the increasing intelligence of the world has successively swept away, have been defended to the last by at least a few of the most honored minds of the age, and have at last been compelled tardily to succumb to a sort of popular verdict, or to the combined force of the lesser lights and younger heads, reluctantly declining to follow longer those to whom they had been accustomed to look to for counsel and intellectual guidance.

In conclusion the speaker remarked that there were some to whom an apology might be due for so protracted an enumeration of the pro's and con's of optimism—a philosophy which may be supposed to have long been obsolete. To such, however, he could only express his regret that the mass of mankind have by no means reached their advanced position. While optimism, as a philosophic tenet, defined by the scholars of a century ago, has, it must be admitted, ceased to engross the attention of thinking minds, the qualified form of it which constitutes the anthropocentric theory, and toward which the foregoing considerations have been principally directed, still forms the very warp of the current philosophy outside of the domain of science, and to a great extent within that domain. It is the essence of all teleological conceptions, and so generally pervades the prevalent views of life and action, as to distort completely the popular conception of the relations between man and the universe. The great mass of men still believe in a conscious intelligence, either without or within the universe, which is perpetually adjusting means to ends in nature. The majority regard that intelligence as in a manner benign and sympathetic, and while shutting their eyes to such facts as have been here set forth, are ever on the alert to gather evidence, however slender, in support of providential interference and intelligent design.

Mr. S. D. Hinman then read a paper entitled *THE RABBIT AND THE SPRING.—A DAKOTAN TALE.*

Upon this paper Prof. Mason remarked that nearly the same story occurs in "Uncle Remus." He said it was possible that the negroes of the South might have learned it from the Southern Indians. He had formerly reasoned that the selection by the negroes of the rabbit as the hero of so many of their stories was because they thought that timid animal best typified their own helpless condition, from which a belief widely prevailed that they were yet to emerge victorious over all the influences that tended to hold them down.

Mr. Gilbert inquired whether the story was regarded as a myth, or whether it belonged to the proper folk-lore of the tribe.

Mr. Hinman thought that it was not believed in as a fact.

FORTY-NINTH REGULAR MEETING, January 3, 1882.

Dr. Robert Fletcher read a paper entitled PAUL BROCA ; HIS LIFE AND WORK IN ANTHROPOLOGY.¹

Dr. Antisell inquired whether the report was true that Paul Broca died of internal aneurism.

Dr. Fletcher replied that this was not developed by the autopsy and was a mere supposition.

Prof. Mason spoke of a letter he had once received from Broca, in which he advised American anthropologists to confine their investigations to their own country as the most promising field of research.

Dr. Antisell remarked that Broca was the first to observe the perforated skulls.

Dr. Fletcher said that he had treated this subject specially in a paper read at a previous meeting, which accounted for his touching so lightly upon it in the present one.

Prof. Mason asked whether it could be considered as the established opinion that the faculty of speech is located in the third frontal convolution of the brain. He said that he had heard both Dr. Otis and Dr. Woodward speak very skeptically about it, and cite a case in which this lobe was carried away entirely, and the man talked more than before.

Dr. Fletcher replied that there was some conflicting evidence on the subject, but that the doctrine had recently gained ground. He

¹“Paul Broca and the French School of Anthropology;” in “The Saturday Lectures,” delivered in the Lecture Room of the U. S. National Museum under the auspices of the Anthropological and Biological Societies of Washington, in March and April, 1882; Boston, D. Lothrop & Co., 1882; Washington, Judd & Detweiler, 1882, pp. 113-142; also separate, as Saturday Lecture No. 6.

said that the views of Dr. Otis and Dr. Woodward which had been given must have been expressed some time ago, and he was quite sure they had been greatly modified since. He thought Dr. Otis believed in the doctrine at the time of his death, and that Dr. Woodward now accepts it with limitations.

ANNUAL ADDRESS OF THE PRESIDENT,

J. W. POWELL.

*Delivered February 7, 1882.*OUTLINES OF SOCIOLOGY.¹

By organized association men live together in bodies politic. That men may live in peace, render one another assistance, and act together as units for mutual protection, is the purpose subserved by organized association. In order that men may associate, their conduct must be regulated. For the regulation of conduct there must be organization, and the plan upon which a body politic is organized depends upon the nature of the regulation for which it is used—organ is adapted to function.

The organization of the body politic constitutes the State.

Again, there must be—

First, some method of determining the particulars of conduct that require regulation and the quality and quantity of regulation required.

Second, there must be means of enforcing regulation.

Third, there must be means of determining whether conduct conforms to rule.

The machinery established by a society for accomplishing these purposes constitutes Government.

Yet again, there are the rules which the body politic determines to be necessary for peace, mutual assistance, protection, and the common welfare, and these constitute the Law.

The science of sociology, from the nature of the functions of social organization, may be fundamentally divided into three sub-

¹“The Saturday Lectures,” &c., pp. 60–82; also, separate as “Saturday Lecture” No. 4.

jects: the constitution of the state, the form of the government, and the regulation embodied in the law—the *state*, the *government*, the *law*.

THE STATE.

A state is a body politic—an organized group of men with an established government and a body of determined law. In the organization of societies units of different orders are discovered. A society of the highest or first order is made up of a number of societies or groups of a second order, and these may again be made up of a number of groups of a third or fourth order. The term *state* as here used embraces the entire body of men included in the largest unit (and consequently all the men of each subordinate unit) when it refers to the body politic as a group of men, and when it refers to the organization it includes the constituent plan of the largest and its included units. It should be noticed that this use of the term state is not consistent with a common practice in this country, but we may illustrate by reference thereto. The term *state* would thus be synonymous with the United States, including its several units of states, counties, townships, cities, wards, and all other subordinate divisions. The term state, then, is used to designate an organized body of people of the highest order, embracing all its subsidiary organizations.

SOCIOLOGIC CLASSES.

In the foregoing characterization of the state it has been considered as a body politic organized for civil government, that is, for the regulation of the conduct of the individuals of the state as they are related to one another. But the conduct of the members of the state, or of the entire body politic, may have relations to other bodies politic; so that conduct must be regulated in its internal relations and in its external relations.

Now, the relations of state to state may be regulated by common agreement, and they are thus regulated to a large extent. But

this regulation is imperfect and weak from the fact that no common government is organized to which all the states are alike obedient. The lack of such a common government for states leads to the settlement of disputes by war. Each state prepares itself to enforce its wishes or defend its rights by resort to arms. It seems probable that in the earliest stages of society all able-bodied men take part in its military affairs. But very early a differentiation is discovered by which a part only of the men belong to the army; and thus we have the *military* class as distinguished from the *civil* class.

In all governments which have hitherto existed, human conduct has been regulated in its relations to supernatural beings. It has always been believed that the welfare of mankind depends largely, or even primarily, upon the will of the gods, or of one god—the Supreme Ruler of the Universe.

The relation of man to his god gives rise to religion. The conduct involved is religious conduct; and hence religion comes to be an important factor in determining the constitution of the state, the nature of the government, and the character of the law.

Thus in the constitution of the state we find three classes of people more or less distinctly differentiated: the civil, the military, and the priestly. As these classes appear in the constitution of the state they also affect in varying degree the form of the government, and the relations arising therefrom are regulated by law.

SOCIAL RANKS.

In many stages of society grades, or ranks, of people are discovered, based upon heredity, possession of land, wealth, and other circumstances giving rise to aristocracies—common people and slaves, patricians and plebeians.

CORPORATIONS.

In many states two grand classes of organizations are found. The first class is directly related to government and embraces the organi-

zations mentioned above as grouped in different orders. The second class is indirectly related to government. These organizations serve a variety of purposes. Men are organized into societies for religious, charitable, educational, industrial, and other ends, and such societies will here be called *corporations*. These organizations of the minor class, unlike those of the major class, do not constitute a part of the government, but they form a part of the state and must necessarily be considered in the plan of the state. While not a part of the government in any important way they are connected therewith. The regulation of conduct involved in the successful working of such corporations may be immediately determined by the bodies of men severally involved, and expressed in charters, constitutions, by-laws, and rules of order. But over all these is the law of the government, with which the rules or laws of the several minor organizations must conform, and for the ultimate enforcement of which government is to a large extent responsible. Thus we have the major and minor organizations of the state, the major and minor laws of the state, and the government of the state directly enforcing the major laws and indirectly enforcing the minor laws.

The science called Sociology in its three great divisions—the state, the government, and the law—deals with all organizations of the people for whatsoever purpose they may be formed.

A part of the regulation of a state belongs to the major, another part to the minor, organizations of the state, but the functions of the two classes of regulation are not clearly and permanently differentiated. A particular system of regulation may be relegated now to the government and now to a society of the minor class, or the system of regulation may be divided between them. For example, the government may entirely control a system of education, or the system of education may be entirely controlled by minor societies; or, again, a part of the educational system may belong to the government and a part to minor societies. The boundary lines between major and minor regulation are ever shifting.

A STATE IS A PLEXUS OF ORGANIZATIONS.

In the foregoing statement it is seen that the grand unit of social organization, the state, is itself composed of many minor organizations, forming units in a descending series, so that the state has a compound structure. It also has a complex structure. Before defining this complexity an illustration from biology may be in place.

An animal is composed of many organs performing different functions,—the organ of thought, the organs of breathing, the organs of digestion, the organs of circulation, the organs of locomotion, and so forth. Running through all these organs and forming a plexus with them, are the systems of tissues—the nervous, vascular, and muscular systems—the whole forming a complicated system of organs and tissues, rendering the organism excessively complex in physical constitution.

In the examination of the constitution of any particular state it will usually be that one system of organization permeates and pervades other systems in such a manner that the individual state is excessively complex. Through the series of units into which the state is organized for the purposes of government, both classes and ranks are interwoven, and through the government units—the classes and the ranks—corporations are interwoven.

In the Muskoki Confederacy there are forty-nine tribes, each one having a government of its own. But these forty-nine tribes are organized in such a manner that a common government is provided for the whole. Now, the confederacy is the grand unit, the tribes are units of a second order. But the clans of one tribe are also the clans of another, so that each clan is distributed through many tribes, and each clan has a government of its own, subsidiary to the government of the tribe, and again subsidiary to the government of the confederacy. The organization for a clan is woven through the organization for a tribe in such a manner as to make the constitution of the state complex.

In those states where the organizations which we have here

called corporations are highly developed, the corporations themselves render the constitution of the state complex. Church organizations do not conform to state lines, but extend their operations and their control over their own members regardless of political divisions.

All states that have been studied have been thus found both compound and complex. Such are the essential characteristics of the social organization of mankind into states.

THE GOVERNMENT.

The differentiation from the state of an organized system of regulation gives rise to government. If a condition of society could exist in which each member in the state should take an equal and like part with all the others in the regulation of conduct, the state would be without a government in the sense in which that term is here used; but in the bodies politic which are known certain individuals are selected by one or other process to perform special functions in the regulation of the conduct of the people composing the state. The government is the sociologic organ differentiated from the state for the regulation of conduct.

The functions to be performed by a government are of three classes—legislative, executive, and judicial. For if conduct is to be regulated it is necessary—

First, to determine in what particulars, and to establish the rules. This gives the law-making power, which will here be denominated the *legislative* department.

Second, to provide machinery for the enforcement of the law. This is here denominated the *executive* department.

Third, to interpret the law. In society the particulars of conduct and the relations of conduct are vastly multifarious, approaching infinity. The formulated rules of conduct—the law—can never so keep pace with conduct itself that every specific act of social life shall have its corresponding formulated rule. It is therefore necessary that the general rules embraced in the law be interpreted and

applied to the specific act. This is usually done by the individual, who is supposed, and whose duty it is, to know the laws of the state ; but the individual may yet have imperfect knowledge. Still, as a member of the body politic, his conduct has its effect upon others who themselves may have imperfect knowledge of the law and its application to specific acts. This imperfection of knowledge necessitates an interpretation of the law. Again, bias of interest, bias of prejudice, and bias of passion, all have their effect in modifying individual opinion relating to the law. Under these circumstances it is found necessary for the state to devise, as a part of its government, some organ for the interpretation of the law in its application to specific acts. This gives rise to the *judicial* department of government.

These three great functions have never been clearly differentiated in the organization of a government ; but the distinctions have usually been perceived and a partial differentiation of organs is ever found.

In the constitution of the state, it has been seen, three grand classes arise—the *civil*, the *military*, and the *religious*. Wherever in the state such classes appear, the form of government is adapted to the regulation which the constitution of the state demands, and in this manner the functions of government may be classified as civil, military, and religious—the military government inhering in the army, the religious government in the priesthood : and armies and priesthods are constituent parts of such governments.

Usually in all stages of society, military government is entirely subordinate to civil government, but there are times in the middle stages of society when the military government assumes inordinate proportions, so that the civil government becomes subsidiary thereto ; but such military governments performing civil functions are ephemeral.

Again, in the constitution of the state, religious organizations invariably constitute an important factor. In the lowest tribes a priesthood is a part of the government. In certain stages of society

a priesthood sometimes acquires inordinate powers, and ecclesiastical, or religious, governments are organized ; but such governments arise only occasionally and are ephemeral.

In the constitution of the state two classes of organization are found—those relating directly to the government, called the major organizations, and those relating indirectly to the government, called the minor organizations, or corporations ; and each organization develops from its own body of members a government of its own, through which, in part, it is related to the government of the state and to other organizations of the minor class. These minor organizations are also directly related to the government of the state and to one another through the individuals of which they are composed.

Government is the specialized organ for the regulation of the conduct of the individuals of the state, and is functionally divided into the legislative, executive, and judicial departments, with a still further functional division running through these, giving civil, military, and religious government. To the government of the state, in its several units and classes, the government of corporations is subsidiary and obedient.

THE LAW.

The law is composed of the rules of conduct which the government endeavors to enforce. These rules of conduct control the individuals of the state in their relations to one another. Conduct, in its relation to the individuals involved, is either directly or indirectly personal. Conduct may be directly personal in its relations to two or more individuals, or it may be indirectly personal in that it affects the relations of the individuals through the medium of property. The first gives rise to what I shall denominate *personal* law, the second to *property* law.

Again, in the organization of the body politic, minor bodies have been described, and designated as *corporations*, including in the term all bodies politic of the minor class, *i. e.*, all private cor-

porations as distinct from municipal or government corporations. The relations of individuals to one another, as members of a corporation, are controlled by the corporations themselves in their organized capacities, but these regulations must conform to the law of the state, and are ultimately relegated for their enforcement to the government. But the control of corporations in their relations to one another, in their relations to the government, and in their relations to the individuals of the state, gives rise to a body of *corporation* law.

Again, since government is differentiated as the organ of regulation, the organ itself must be controlled—the conduct of the government must be regulated. This gives rise to what I shall denominate *government* law.

It has been seen that the conduct of a state, and of the individuals of a state, has relation to other states. The rules for the regulation of this conduct gives rise to *international* law.

As no common government exists between states to enforce international law, armies are organized, and for the regulation of their conduct *military* law is developed.

The conduct pertaining to the relation which exists between men and deity gives rise to the organization of ecclesiastical bodies. For the government of these bodies, and for the enforcement of the rules of conduct which religion imposes, *religious* law appears.

The law, then, the body of rules which the state endeavors directly or indirectly to enforce, may be properly classed as follows :

1. Personal law.
2. Property law.
3. Corporation law.
4. Government law.
5. International law.
6. Military law.
7. Religious law.

In addition to this classification of law on the basis of the particulars of conduct to be controlled, another fundamental

classification is found running through and interwoven with each of the others. This classification depends upon the method by which regulation is accomplished. General rules of conduct are established, and these general rules are applied to specific acts. Thus duties and rights, or rights active and passive, are determined. Usually, to these rules determining rights, the individuals of the state conform their conduct; but to an important extent they do not. To the extent that conduct is conformatory to the law, right is done; to the extent that conduct is not in conformity with the law, wrong is done. Now, government does not attempt to control conduct by directly enforcing right-doing, but indirectly, by punishing wrong-doing, and this gives rise to a body of laws relating to wrongs, which may be designated as *criminal* law.

Crimes may be committed against personal law, property law, corporation law, government law, international law, military law, and religious law; so that the classification of law relating to rights and duties furnishes the proper basis for the classification of law relating to wrongs, *i. e.*, crimes.

COURSE OF EVOLUTION OF THE STATE.

In considering the particulars of conduct that states have attempted to regulate we find they can be classified on still another basis than that presented in considering the subject of law. Conduct may relate to the perpetuation of the species, or it may relate to the welfare of the individual. Though this classification serves no important purpose in the study of the subject of law, yet it is necessary in considering the constitution of the state and the form of the government.

In the earlier and lower stages of society, conduct relating to the perpetuation of the species is held to be of primary importance, while conduct relating to the welfare of individuals is held to be of secondary importance, in such a manner that the organization of the state is based primarily on the former and secondarily on the latter.

In the perpetuation of the species the functions of reproduction are dependent upon the biologic organization of mankind, dividing the human race into two classes—*male* and *female*—and the very earliest states yet discovered have their plans of organization based on sex, and composed of classified bodies of kindred.

This may be stated in another way. In the earliest forms of society conduct involving the relations of the sexes and the relations of kindred arising therefrom was first brought under regulation. The primary and principal source of disagreement among primitive men at the inception of organized society grew out of their desires for the possession of women. Men first came into conflict with one another on account of women, and to live together in peace it became necessary to organize government and enact law regulating marriage and kinship relations arising therefrom. The government and the law relate primarily to kinship, regulating the relation of the sexes, and the relation of the several members of bodies of kindred; that is, the state is organized on kinship. Governmental functions are performed by men whose positions in the government are determined by kinship, and rules relating to kinship and the reproduction of the species constitute the larger body of the law. The law regulates marriage and the rights and duties of the several members of a body of kindred to one another. Individuals are held responsible only to their kindred, and certain groups of kindred are held responsible to other groups of kindred. When other conduct, such as the distribution of game taken from the forest, or fish from the sea, is regulated, the rules or laws pertaining thereto involve considerations of kinship, and this is extended so far that a large body of rights to property are kinship rights. In this manner all the earlier forms of the state of which we have knowledge are based on kinship. This gives us kinship society and tribal government.

In the highest forms of social organization discovered in the nations of civilization the regulation of conduct embodied in the government and the law, relates chiefly and primarily to the welfare

of the individual, and secondarily to the perpetuation of the species; and of the conduct relating to the welfare of the individual that which relates to property has an overwhelming predominance.

In the earliest stages of society small wealth is accumulated, and industries for the production of property and wealth are comparatively undeveloped. In the higher stages of society greatly accumulated wealth is found, and industries are differentiated and industrial organizations multiplied beyond all others. As, therefore, the organs of government must be adapted to its functions, the plan of government in such a state must be based upon property. Thus property, society, and national government are constituted.

In kinship states the fundamental classification of the people for the purposes of government is by kindred; in property states the fundamental classification of the people for purposes of government is by territory. Between these stages—the lowest and the highest—many intermediate forms are found. No hard and fast lines can be drawn. A clear distinction can be made only between the lowest and the highest. Survivals of kinship society exist in all governments where position, *i. e.*, office, in the government is hereditary, while property society with the government of the highest civilization is reached only by republics.

The history of the constitution of the state is the history of the evolution of kinship society into property society.

There is yet another way by which this evolution may be characterized, namely, by the progressing differentiation of the organs of the state, and by the progressing integration of states. The differentiation of organs in the state is represented in three ways:

First, by the multiplication of organs of government.

Second, by the multiplication of the orders of units and the specialization of the subordinate units so that subordinate organizations perform special functions. Thus cities may be divided into wards, counties into towns.

Third, by the multiplication of corporations for specific purposes. Such organizations in the lowest stages of society appear only in a

crude form, but as society advances they are perfected and greatly multiplied, until in modern civilized society a state becomes a vast plexus of corporations.

In the earlier stages of society each state is small, being composed only of a body of kindred by consanguinity and affinity, actual or artificial. As each state is small many states are found. In order that unification of states may progress organization by kinship must give way, and gradually it does give way, to be replaced by organization on a property basis. Organization on a property basis appears in many ways, but chiefly in two. First, captives in war and other persons are made slaves, and themselves become property; and, second, a particular form of property—land—gradually comes to be of prime importance, and is at last taken as the basis of the primary classification of the state, which is territorial.

By various processes of alliance, by conquest, by development of feudalities, and by slavery, states are integrated, and by the development of the organs of government and private corporations, the classes of the state are differentiated, and with this the plan of the state is changed from a kinship to a property basis.

COURSE OF EVOLUTION OF GOVERNMENT.

The earliest form of government of which we have knowledge consists of an assembly composed of men, from which are excluded all deemed too young or too old to exhibit due wisdom. This assembly is the law-making power, *i. e.*, the legislature, and the law applying power, *i. e.*, the court. It is, in fact, the body of able men meeting to confer and decide upon conduct, and is essentially legislature and judiciary undifferentiated. This assembly has a presiding officer who obtains the position by common consent or formal choice, and who sometimes acts as an executive officer in carrying out the decisions of the assembly. But this executive power, though it may sometimes, does not invariably inhere in the presiding officer.

Sometimes, and perhaps usually, the executive power is delegated to a committee of the assembly. The committee may be appointed temporarily to carry out a specific determination of the assembly, or it may be a standing committee to carry out a class of determinations. The form of government thus described probably exists at present in some of the tribes of Australia and elsewhere, as such accounts are given by travelers and students of ethnology; but these accounts are incomplete, and have been made by persons not thoroughly trained in this branch of anthropologic research, so that altogether the existence of such a government is at present uncertain. It is also probable that this form of government has existed in past times among tribes who have now advanced beyond it. The line of argument on which this is based cannot here be presented, and it is but fair to say that positive conclusions have not been reached.

A somewhat higher form of government has been discovered in America and elsewhere, which may be more thoroughly described. In this the assembly of the people is more definitely organized. The presiding officer is formally selected, and his tenure of office is for life, unless otherwise formally determined by the assembly for cause. In addition to this, a chief or system of chiefs is found whose duties are executive. The chief is also a member of the assembly, but is not a chief by virtue of such membership but by choice of the people. The chieftaincy is never hereditary.

In the most highly developed governments the three great classifications of governmental functions are highly, though not completely, differentiated, giving rise to legislative, executive, and judicial departments, represented by the *assembly*, the *ruler*, and the *court*.

The assembly itself is elaborately organized and differentiated into two or more correlated divisions. Executive functions are highly differentiated and distributed among various classes of officers over whom the ruler presides. The judicial functions also are differentiated, and superior and subordinate courts are organized. Between the two forms thus described, many intermediate forms

are discovered, and the course of progress is wayward*and various. In the earlier part of this course, judicial functions are to a greater or less extent assumed by the executive, and for a long time this division of the functions of the court between the two departments of government continues—being claimed, now by one, now by the other. At times, too, in the course of progress, legislative functions are assumed by the executive department, and a conflict is waged for supremacy. At last, by various processes, the court is organized.

Three of these processes must here be mentioned. As states increase in size the business of adjudication becomes so great that proper attention cannot be given to the multiplicity of cases arising. Under these circumstances committees of the assembly are appointed with judicial powers, at first extremely limited but gradually enlarged, until courts are developed. On the other hand, where judicial power has to a greater or less extent been assumed by the executive department, the rulers find themselves overwhelmed with business and appoint subordinates in the first instance to adjudicate specific cases, but gradually the powers of these subordinates are enlarged, until courts are thus established.

Again, ecclesiastical bodies claiming superior virtue and wisdom sometimes assume to adjudicate, but such adjudication is gradually relegated to specified officers of the body, and thus ecclesiastical courts are developed.

The courts originating from the assembly, from the ruler, and from the ecclesiastical body alike, may be more or less multifarious. When they spring up in the same state their jurisdiction is at first imperfectly defined. Each strives for supremacy, and thus jurisdiction overlaps jurisdiction. This conflict ultimately results in the organization of a system of courts integrated in a superior court and differentiated by the establishment of a variety of inferior courts with jurisdiction more carefully defined, the function of the inferior courts being controlled and restricted within proper bounds by appeal to the superior.

Thus, at last, the functions of the primitive assembly, originally legislative, executive, and judicial, are differentiated, and the legislature, the ruler, and the court are established.

THE COURSE OF EVOLUTION OF LAW.

In the development of the tribe into the nation, conduct develops from extreme simplicity to extreme complexity, and for the regulation of conduct the law must likewise develop.

PERSONAL LAW.

A large part of personal law belongs to family law. Perhaps the earliest and lowest form of the family is that in which brothers in a group marry their own sisters in a group: all the brothers are the husbands of all the sisters. The family is thus composed of husbands and wives, parents and children, grandparents and grandchildren, and brothers and sisters. Collateral lines of kinship are not established. There are no uncles and aunts, no male cousins and female cousins, and no nephews and neices. This is known as the Punaluan family, or system of kinship.

Another form, known as the Malayan family, or system of kinship, is found, involving a larger tribe and a higher organization. In this, a group of men, being brothers, marry a group of women, sisters to one another, but not sisters to the men whom they marry. For the regulation of this form of communal marriage a tribe is divided into classes. Often there are three classes, which are divided into male and female—making in all, six. Let these be represented by letters: A represents a male class, and A¹ a female class. The class A are brothers and the class A¹ are their sisters. B represents a class, and B¹ a class, brothers and sisters; and C and C¹ are like classes. Then the class A, being brothers to one another, may not marry their sisters A¹, but marry the class of women B¹ who are sisters to one another. The class B marry the class C¹, and the class C marry the class A¹. Now, in this family, descent is in the female line. The children then of A and B¹ will belong to the

class B and B¹, the children of B and C¹ will belong to the class C and C¹, and the children of C and A¹ will belong to the class A and A¹, and through these cycles the generations pass.

The kinship system is further developed in this family, and gives brothers and sisters, fathers and mothers, sons and daughters, grandfathers and grandmothers, and grandsons and daughters. It also gives aunts and uncles. The children call their father and father's brothers, all fathers, and their mother and mother's sisters, all mothers; but their father's sisters are aunts, and their mother's brothers are uncles. The children of their father's brothers they call brothers, the children of their mother's sisters they call sisters; but the children of their father's sisters they call cousins, and the children of their mother's brothers they call cousins.

This family is widely spread in Australia and elsewhere, and the kinship system is still more widely spread, as it exists among all the tribes of North and South America, in parts of Europe, Asia, and Africa, and in some of the islands of the sea.

The Punaluan system of kinship is known to exist, but the form of communal marriage is not known. The Malayan system of kinship and marriage is known. Its simplest and most common form only has been given.

The development of this into the polygamic and monogamic systems of marriage is accomplished in diverse ways among many tribes. The group of husbands and group of wives constituting one family comes to be very large and narrower restrictions are adopted—thus, sons of one mother will be married in a group to the daughters of another mother, and various other restrictive regulations will appear, but all involving a common principle, namely, that the husbands and wives have no choice. Selection is made by legal appointment.

Legal appointment develops into individual selection through three processes:

First. The parties interested, consulting their own wishes, elope; and marriage by elopement, though illegal at first, is made legal on

the day of jubilee. This procedure widely prevails among the North American Indians.

Second. It oftentimes happens that in the vicissitude of life certain groups, or families, of sisters increase in number, while the groups of brothers to whom they belong decrease in number, and *vice versa*. Under these circumstances a few men are entitled to many wives, and the law holds this to be justice. In such cases it may happen that a man who belongs to a large male group having rights of marriage in a small female group, will, with his friends, capture a bride from some larger group of women. This is always resisted, and conflict ensues. If the capturing party succeed, the law then holds that the warfare was the final arbitrament and the controversy ends; and if the capturing party fail, the contest must, in like manner, cease.

Third. Marriage by capture develops into a third form. A man being entitled to more than one woman is challenged by a man who, by the vicissitudes of life and death, is entitled to none, and the right to a woman is thus decided by wager of battle between the two men immediately interested. This duel is gradually regulated by law in such a manner that fatal results do not ensue, and the conflict ends controversy, and thereafter the disputants are, themselves, friends.

These three forms of marriage—by elopement, by capture, and by duel, are gradually regulated, and come to be recognized as legal, and so communal marriage is developed into polygamic and monogamic marriage; and thus by a long process the Malayan system of marriage and the Malayan system of kinship are developed into the monogamic family and kinship. But it usually happens that the system of kinship embodied in the terms of relationship, remains longer than the system of marriage, that is, the evolution of language does not keep pace with the evolution of customary law, so that we find many tribes having the Malayan system of kinship, yet not having the Malayan system of marriage,

but having polygamic marriage and marriage by legal appointment, and with these, marriage by elopement, by capture, and by duel.

In the family law of very early society descent is in the female line, the control of the children belongs to the mother and her consanguineal kindred, and the father and his kindred have no control over the family. The husband is but the guest of the wife and her friends.

During the process of development from communal marriage, and the system of kinship involved, to monogamic marriage and its system of kinship, a change from descent in the female to descent in the male line occurs, and with this change the control of the family is relegated to the husband and father, and rapidly this control becomes absolute, and the patriarchal family is established, in which the father has power of life and death over his wives and children and all their descendants; but gradually this power is regulated by law.

A method by which descent is changed from the female to the male line, that is, by which mother-right is changed to father-right, appears among the North American Indians. When the gentes of which a tribe is composed do not live in a compact village but are spread over a large area of country, so that each gens lives alone, separated by miles of distance from the others, the consanguineal relatives of the wives, who are the guardians and masters of the family, are not present and cannot exercise control. Under such circumstances authority is gradually assumed by the husbands, and the line of descent is ultimately changed. There may be other methods by which this change is made.

PROPERTY LAW.

Property law is naturally divided into two classes—property in *chattels* and property in *land*.

To a large extent in primitive society chattel property is communal—owned by classes or clans—but a few articles, such as clothing, ornaments, and some implements and utensils, are owned by in-

dividuals, yet no large accumulation of these things is permitted to the individual. Under these circumstances barter and sale are clogged because individuals cannot freely exchange—the consent of two bodies of persons being necessary therefor. As industries are differentiated, that is, in the beginning of the differentiation of labor, articles are exchanged by regulation—the price is always the legal price. Inheritance is by clan, not from parent to child.

In the progress of social organization communal chattels become personal property. Inheritance by clan gradually becomes inheritance by nearest of kin, and, finally, wills are invented, and inheritance by designation of the owner is developed. Then with the development of money, barter is changed into sale, and legally fixed price, by certain curious processes, is changed into competitive price.

In the most primitive society the land is held by the state and used only as a hunting ground, or as the source of vegetal food naturally grown thereon, while the streams and coasts are held as fisheries; but where rude cultivation begins small areas are redeemed, and usually cultivated land is held by tribe or clan. Thus, tenure to cultivated land is communal.

Communal ownership is gradually developed into ownership in severalty by a variety of processes interesting in themselves, but multifarious and complex, so that the subject may not here be treated at large.

With the change in the character of tenure to property from communal to individual ownership, there grows up a large body of law relating to contract.

[The consideration of the evolution of corporation law is omitted.]

GOVERNMENT LAW.

In lower tribes, government law consists of a few simple rules, regulating the manner of calling the assembly, the order of deliberation, and the method of announcing the decision, while the

chief or committee executes the law in obedience to a few equally simple rules. In higher nations, where the legislature, the ruler, and the court appear, government law is greatly elaborated. The legislature is organized by processes provided by law, and controlled by organic, or constitutional, law, and a body of parliamentary law is developed regulating its method of procedure. The executive department is governed by organic law, by law emanating from the legislature, and by a large body of rules originating within itself. The judicial department is also controlled by organic law, by directory laws emanating from the legislature, and by the rules of the court, involving a complex system of procedure.

From such simplicity to such complexity do we arrive by the processes of evolution.

CRIMINAL LAW.

Of crimes resulting from the regulation of the relations of the sexes, marriage within the proscribed group is held to be the most heinous in primitive society. It is never condoned, never compounded. Infidelity after marriage may be condoned or compounded.

Crimes relating to personal injuries include murder, maiming, and slander. Murder may be punished by the taking of life—not necessarily the life of the murderer, but one of his clan. But murder may be compounded, and primitive law fixes the value of individuals according to sex and rank. Murder may be atoned for by substitution, that is, the murderer may be expatriated, driven from his family, and thus become dead to his own people, and then he may be adopted by the injured family and made to replace the murdered person. Thus the wife of the murdered man may adopt the murderer for her husband, and, in this adoption he loses his own name and all relations of kinship, and accepts the name and kinship relations of the murdered man.

Maiming is punished by maiming—"an eye for an eye and a tooth for a tooth"—and maiming may be compounded, and the value of the several parts of the body is specified by law.

Slander is punished the same as the crime alleged in the slander, and slander may be pleaded as a justifying cause for murder and maiming; slander may also be compounded.

In primitive society by far the largest body of crimes is included under the practice of witchcraft, and this is terribly punished. Abnormal conditions of body, aberrations of mind, and infelicities of temper are all interpreted as evidences that the possessors thereof are uncanny people, and to a large extent deafness and blindness before old age from causes that cannot be readily understood, and all loathsome or strange diseases, are likely to be attributed to sorcery, so that the practice of witchcraft is everywhere believed in, and witches and wizards are multiplied. Witchcraft is punished by death, but after conviction in the court, appeal to supernatural decision is always permitted, and thus we have the origin of trial by ordeal.

Criminal law in the higher stages of society need not be characterized, but certain lines of evolution may be pointed out. The groups in which marriage is prohibited, giving rise to the crime of incest, change from artificial groups to groups constituted by degrees of consanguineal kinship, male and female. Thus classifications by artificial and analogic characteristics give place to classifications by essential and homologic characteristics. Gradually too, in the progress of society from the earliest to the latest stages, the motive of the murderer is considered, and accidental killing and maiming are differentiated from willful murder and other personal injuries, and in the higher stages of society, such willful injuries, being essential crimes, are not compounded nor atoned for by substitution.

In the crimes which come from the unlawful acquisition of property the punishment by multiple restitution found, in the lower states, is superseded by fines which go to the state and by imprisonment. In the lower stages of society property crimes are thefts; in the higher stages, property crimes are thefts and frauds.

In the lower stages of society a large body of the crime is witch-

craft, and this gradually disappears with the progress of culture. It should be noticed that in early society there is a very large body of artificial crimes—especially those relating to sorcery. Again, there is a large body of artificial crimes relating to personal injuries, from the fact that willful injury is not differentiated from accidental injury. In the course of evolution such artificial crimes are eliminated from the law. On the other hand, by reason of the ever increasing complexity of the relations of men, the classes of real crimes are multiplied.

There is yet another line of progress. In primitive society two principles are found to exist side by side as fundamental theories in the administration of the law.

The first is that justice must be done—that justice which the primitive law recognizes.

The second, that there must be end to controversy so that peace may prevail and society be not disorganized; and this must be accomplished though the former fail.

To secure end to controversy there is resort to two methods:

First, days or other periods of jubilee are appointed at which all crimes, except murder and incest, are forgiven. In the lowest societies it is a day of jubilee, coming once a year; in higher societies it is a year of jubilee, coming at longer periods. With progressing society this method of ending controversy is adopted in the case of crimes which are manifestly artificial in the state of culture to which the people have arrived, and by this means willful murder is at first differentiated from accidental killing.

Second, controversy is terminated and the punishment of artificial crime is avoided by the establishment of cities of refuge.

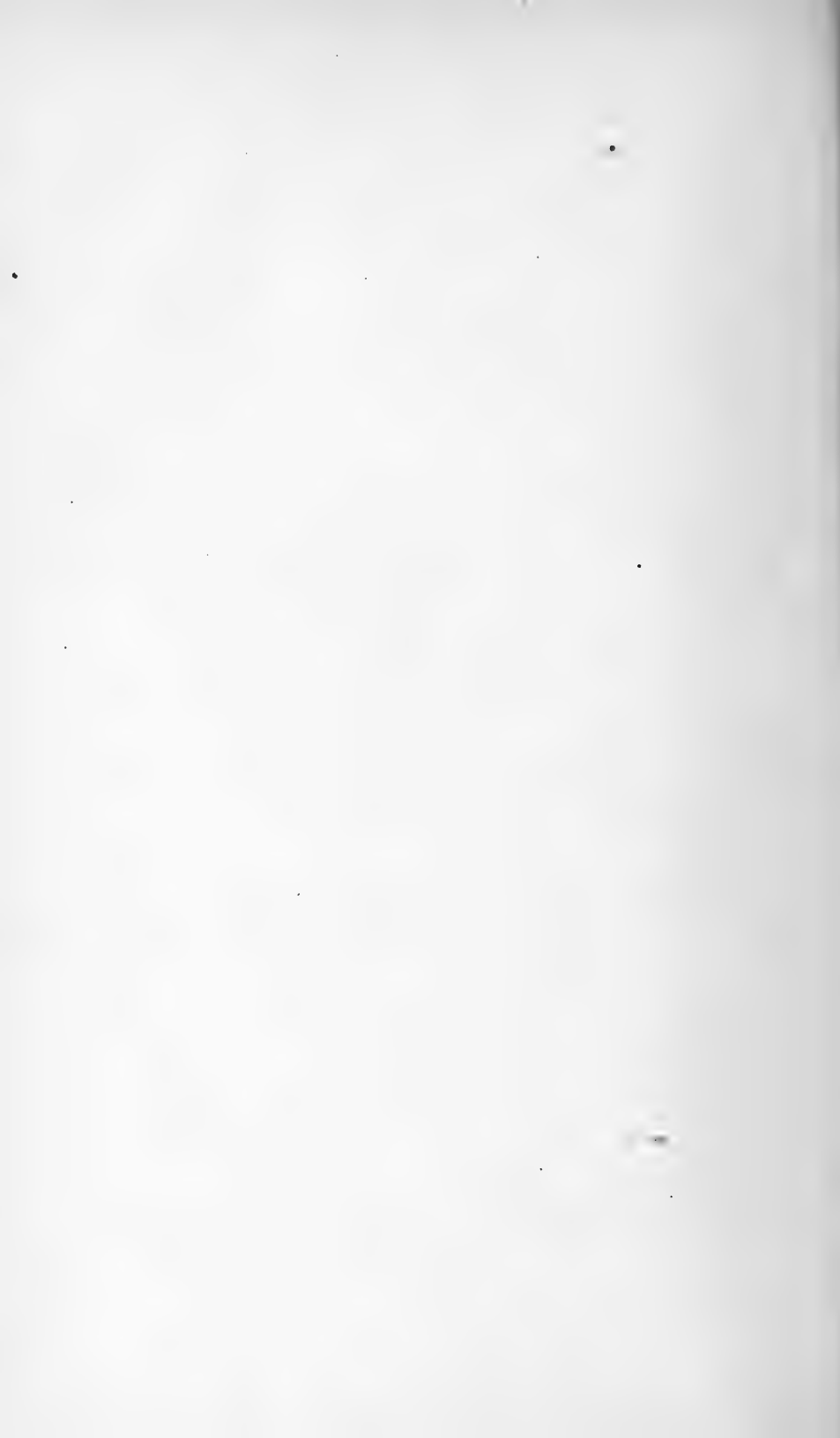
Now, cities of refuge come to be such in a curious manner. In the early history of mankind, cities are states and autonomous; one state does not punish the crimes committed in another; and men committing crimes flee from their own states to others, become incorporated therein by adoption, and thus secure immunity from punishment. When on the first organization of nations,

two or more city-states are consolidated and placed under one general government, certain cities often remain as places of refuge, but with an important restriction, namely, that the crimes belong to the classes which have been here described as artificial.

Thus days of jubilee and cities of refuge are important agencies in the evolution of criminal law.

The growth of law in its entire course is governed in many important respects by the theory of the origin of law and the source of its authority. This subject involves the discussion of the evolution of philosophy and cannot now be undertaken. It is the highest and most important subject with which the mind of man can grapple, as it involves the whole theory of human conduct—the ethics of mankind.

In the foregoing the organization of society for government, *i. e.*, for purposes of regulation, has been considered. This is the organization to secure peace. The organization of society by the differentiation of industries and their integration through commerce has been necessarily omitted.



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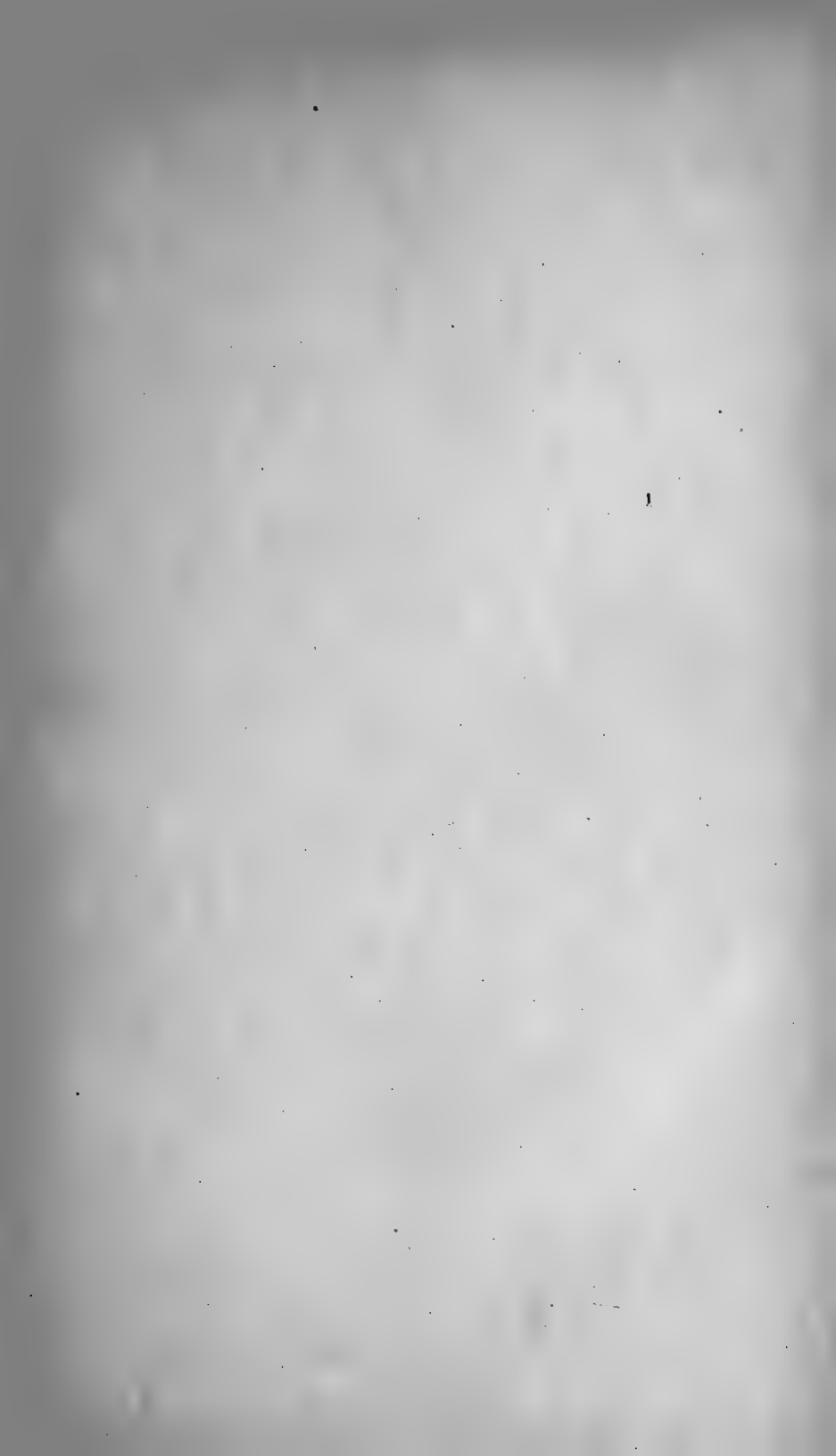
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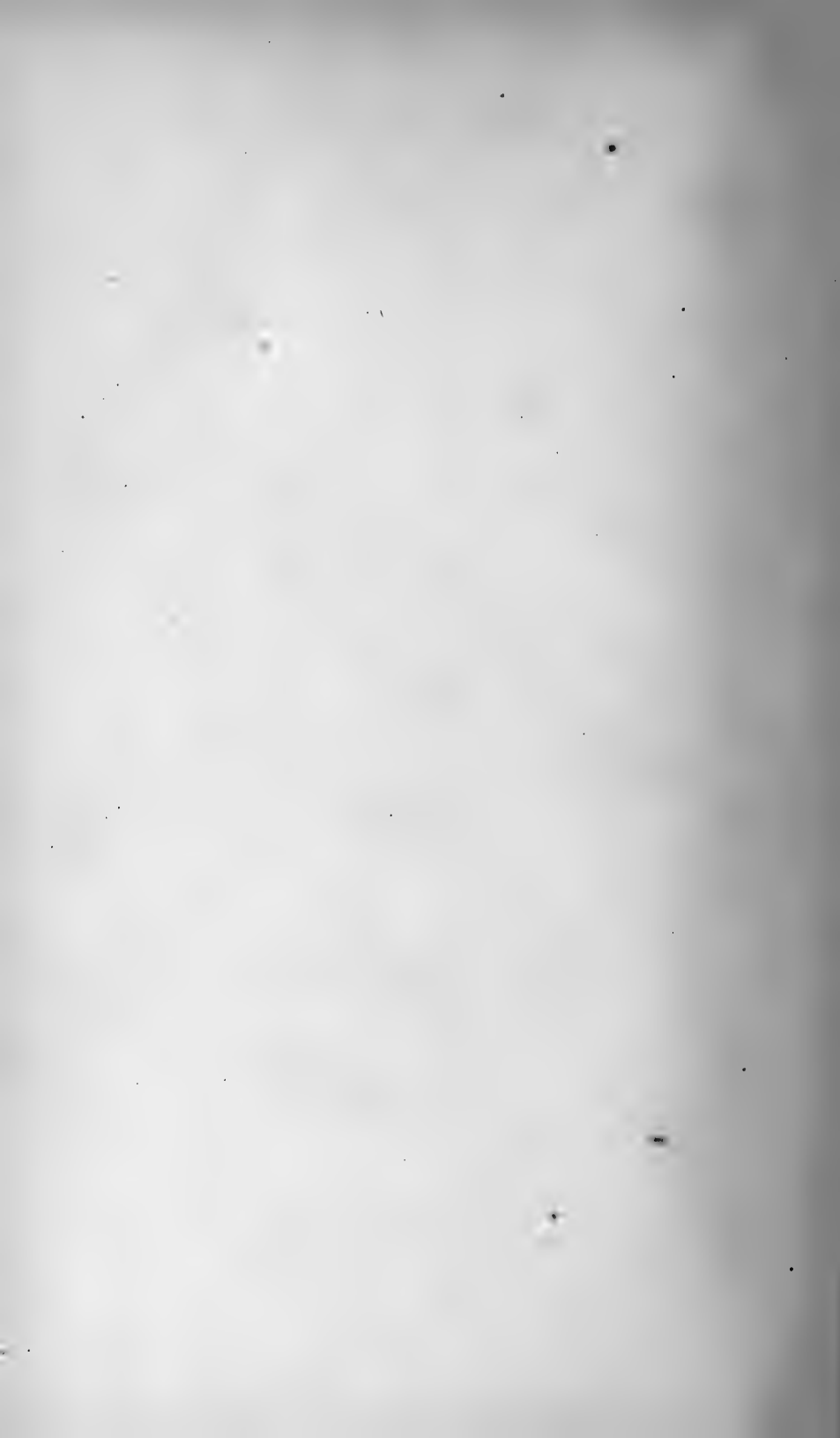
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ABSTRACT OF TRANSACTIONS
OF THE
ANTHROPOLOGICAL SOCIETY

OF
WASHINGTON, D. C.,

WITH THE
Annual Address of the President,

For the First Year, ending January 20, 1880, and for the
Second Year, ending January 18, 1881.

Prepared by J. W. POWELL.

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ABSTRACTS OF PAPERS
READ BEFORE THE
ANTHROPOLOGICAL SOCIETY
OF
WASHINGTON, D. C.,
FOR THE
Year Ending January 20, 1880.

FIRST REGULAR MEETING.

MARCH 4, 1879.

Relic Hunting.

By FRANK H. CUSHING.

The speaker, who has had much experience in collecting archæologic materials in the field—on the shores of many of the lakes of New York and in the valley of the Potomac—gave an interesting description of the topographic features to be observed as indices of ancient Indian village sites. His conclusions were, that the Indians in choosing these sites were influenced by a double set of motives: the first, riparian convenience, as they obtained their subsistence in large part from the water; the second, defensive advantages. He then gave the distinctive features of fortified towns as they appear from a study of their remains, and in conclusion described the communal ash-heap into which the bones, pottery, and broken implements of camp life were sure to drift.

Some Modes of Indian Burial.

By P. W. NORRIS.

Mr. Norris, the Superintendent of the Yellowstone National Park, gave a description of several modes of Indian burial that had come under his observation. He described platform burial on the prairies and plains, and believed that the Indians had adopted this method to protect their dead from the wolves.

In a second method as seen by him the body is rolled in the flayed skin of a horse or buffalo, which, on shrinking and hardening, forms an enduring shield for the body, which is afterwards placed in a cool, dry cavern. He had known Indians on the war-path to wrap their slain in blankets and suspend them from the branches of trees, or to lower them by lariats over inaccessible ledges where they were secure from beasts of prey.

SECOND REGULAR MEETING.

MARCH 18, 1879.

Some Indian Pictographs.

By G. K. GILBERT.

Mr. Gilbert, who, as a geologist, has traveled extensively in the southwestern portion of the United States, presented a large number of Indian pictographs collected by himself in that region.

The paper was illustrated by an extended series of Indian drawings copied from three localities, viz., Partridge Creek, on the Colorado Plateau, in Northern Arizona; Temple Creek Cañon, in southeastern Utah; and Oakley Springs, fifty miles northeast of the Moki Villages, or Province of Tusayan, in Arizona. At all of these places the drawings were made on smooth, natural surfaces of sandstone by

picking with a sharp implement, a line being produced by a series of indented dots. At Temple Creek Cañon pigments were used in addition.

The drawings at Partridge Creek are grotesque, and their meaning not clear. The locality is not now inhabited, but is a common hunting ground of the Hualpais, the Avsupais, and perhaps the Tonto Apaches.

At Temple Creek the human form is many times repeated, and also that of a number of animals, including the mountain sheep, rabbit, bear, and fox. The rainbow is drawn with three concentric lines, suggesting that three colors were recognized. The locality falls within the territory of the Utes, but numerous ruins attest the former presence of the Pueblo Indians, and the drawings are ascribed to them.

At Oakley Springs the pictures are made by Mokis, who pass that way *en route* to the lower cañon of the Little Colorado River, whence they obtain their supply of salt. Each Indian on each trip inscribes his totem *once* on the rock. The drawings successively made by an individual are ranged in a line, and show their common origin. The same token or symbol drawn by two individuals exhibits such differences as does a name in like manner among civilized people. The number of drawings is very great—2,000 or 3,000; but the number of objects represented is much smaller. The subjects most frequently presented are growing corn, rain clouds, arrows, bows, stars, the sun, bears' tracks, lizards, masks, calabash dippers, corn-ears, squash-blossoms, houses, lightning, bird-tracks, crows, eagles, wolf-heads, and rabbits—all of which are several times repeated. It is noteworthy that one of the signs for a star is a simple cross with equal arms. Many of the totemic drawings show a conventional character. For example: The bear-track at Oakley Springs is a curved semi-lunar figure with five curved lines springing from the straight side and standing for toes; while the bear-track at Temple Creek is a sculpture representing the actual indentations of the sole and claws of a bear's foot. In conclusion Mr. Gilbert stated that most of

the information in regard to the Oakley Springs' etchings was obtained from Tubi, an intelligent Moki Indian, who was formerly chief of the village of Oraibi.

Observations on Aztec and Guatemalan Antiquities.

By OTIS T. MASON.

Prof. Mason exhibited two large cartoons of Aztec and Guatemalan antiquities, and stated that the object of his communication was to draw attention to Dr. Habel's paper just published as one of the Smithsonian "Contributions to Knowledge," in which a remarkable group of sculptures in southern Guatemala are described.

The author of the contribution having affirmed that the sculptures were not of Aztec origin, Mr. Mason took occasion to show that they probably were. In order to do so the attention of the society was called to various points of similarity between the symbols of the Habel sculptures and those found upon the structures of the Aztec capitol. Especial stress was laid upon the symbol for speech, which is exhibited on the Guatemalan slabs with a profusion hitherto unknown. The speaker believed this to be a purely Aztec device, and in confirmation of this view called attention to the recurrence of the same symbols in the paintings of the old *Mexican Codices*, but especially to an illustrated paper by Señor Orozco y Berra, in the fifth part of the *Andes del Museo nacional de Mexico*.

The Catholic missionaries of the sixteenth century, impatient of the delay occasioned by the difficulties of learning the language of the natives, sought to convey to them the truths of the Christian religion by symbols drawn from the paintings of the church and the Aztec iconography. In one of these manuscript pictographs illustrating the Lord's Prayer, this very symbol of speech is given in a rude form to indicate the prayer of the suppliant and the blessings of

the *padre*. The deification of the Tecpatl, or obsidian knife, in the Aztec mythology and in the Guatamalan slabs, was taken as an indication of the Mexican origin of the latter.

THIRD REGULAR MEETING.

APRIL 1, 1879.

Arrow-Head Making.

By FRANK H. CUSHING.

Mr. Cushing described his own experiments in making stone arrow-heads, by sudden pressure, with a sharp-pointed bone. Many Indian tribes were known to make their arrow-heads in the same manner. With specimens from the National Museum, he pointed out the different stages exhibited in the fashioning of each-implement.

Indian Pictographs.

By G. K. GILBERT.

This paper was a continuation of one read at a previous meeting. As it was based upon illustrations presented to the society, it is difficult to give a verbal abstract.

FOURTH REGULAR MEETING.

APRIL 16, 1879.

Color-Blindness as Affected by Race.

By SWAN M. BURNETT.

Dr. Burnett gave the result of an examination by him of 3,040 pupils in the schools of negro children in the District of Columbia. He spoke of the influence exercised by

sex, giving the percentage found in over 1,200 examinations as 0.26 per cent. among females. He attributed this low percentage, as compared with the male sex, to the greater development of the color-sense in women on account of their occupations demanding a nicer discrimination of shades of colors which had been transmitted to the daughters as a sexual peculiarity. It was for biologists to determine whether a faculty, which under present conditions had no connection with the sexual functions, could be transmitted as a sexual peculiarity.

No reports regarding color-blindness as affecting the different races had been made except by Magnus of Breslau. He found the Jewish children affected in about 4 per cent., whereas the Christian children closely approximated to 2.05 per cent.

Dr. Burnett found the negro children of both sexes affected to the extent of 0.78 per cent.; the boys in 1.06 per cent.; girls, 0.11 per cent. This low percentage, as compared with white children, he thought, might be referred to a largely developed capacity for color perception in the antecedents of the negroes in this country. It might be that in the earlier condition of life a good perception of color was necessary for their preservation, and naturally, under such circumstances, those survived whose faculty in this particular was most highly cultivated.

A large number of the examinations made by him were of persons of mixed blood, but often a small admixture of the blood of a race seems to carry with it an immunity from, or a tendency to, a disease (as shown by him in the case of trochoma or granular lids, from which the negro seems to be free). Hence, he infers that this may be the case in anomalies in the perception of colors in the negro race.

FIFTH REGULAR MEETING.MAY 5, 1879.

Progress of Archæologic Research in the United States.

BY WILLS DE HASS.

Dr. De Hass' paper was an interesting historical review of the more important discoveries in the United States.

The Old Roman Senate: A Study of Deliberative Assemblies.

BY J. HOWARD GORE.

Prof. Gore sketched the development of the legislative government of Rome, showing that the Senate originated previous to the foundation of Rome, and that Romulus merely transferred the earlier custom.

The first subject which occupied the attention of the Senate was the addition of members from the allied tribes.

The political ascendancy was modeled after the family, at first having as a head the King, afterward the Senator, who was the first *Censor*. Subjects for discussion were introduced by the King, afterward by the Council, next by any magistrate.

All measures had to be ratified by the people before they became operative as laws.

The mode of voting was formerly by passing to different sides of the house; then by voices, and lastly by ballot.

In its glory the Senate exercised more power than the British Parliament, and better represented the people than any assembly since organized, unless that of France be excepted. No legislative government ever possessed so strong a balance of power.

Indian Color Names.

BY ALBERT S. GATSCHET.

Mr. Gatschet's paper contained an enumeration of twenty or twenty-five color-adjectives in the following Indian languages: Klamath of Oregon, Nez Percé, Shawnee, Atfalati branch of the Kalapuyan family, Michopdo, of California, Santee, of the Dakotan stock, and Mákokian.

The conclusions arrived at were, that often in the dialects considered no real word for color, in the abstract, exists; that the Indians use as many names, and, therefore, recognize as many color distinctions as we do; that many of their names, however, designate checkered or medley colors; that yellow and green sometimes coincide, both being referred to the color of the grass; that blue and green sometimes coincide; and, finally, that Indians often start from other principles than ours in naming their colors.

SIXTH REGULAR MEETING.

MAY 20, 1879.

Indian Pictographs in New Mexico.

BY MILES ROCK.

Nineteen of the more distinct etchings presented by Dr. Rock were found and copied in September, 1878, at the west entrance of Cook's Cañon, about nine miles west of old Fort Cummings, in Grant County, southwestern New Mexico.

They were found on the perpendicular faces of an outcrop of sandstone at the top of a foot-hill of which Cook's Peak is the highest point. There were a great many symbols in all stages of obliteration by weathering. The most distinct and deepest cut were two Greek crosses, each surrounded by a line fringing the arm at each angle. There was also a Roman cross supported by two braces, a human face, a jack-rabbit, four five-toed foot-marks, a running snake, and per-

haps a Spanish bayonet-plant, a stream of water with a spring near the bank, a steel trap, a rude representation of a cañon blocked up by a snow-drift, and a snake at a nest of eggs.

Of the six remaining etchings Mr. Rock withheld his opinion. As these remains are in the territory of the Apache Indians, he attributed the work to them, and also suggested that the early Spanish missionaries may have made the crosses, as they were more sharply cut and exact than the others.

The slope below these remains was littered over with flakes of agate and chalcedony and a profusion of pot-sherds—both plain and colored. There were, also, several mortars excavated in the rocks of the cliff.

Aboriginal Paint Quarry:

By ELMER R. REYNOLDS.

Mr. Reynolds spoke of the discovery of an aboriginal paint quarry near Bladensburg, Maryland, made in February last while searching for the site of an old encampment among the hills southeast of Benning's Bridge. The abandoned quarry is situated near Indian Springs on the estate of Rev. R. W. Lowrie.

The stone was found in piles on the summit of the hill above the spring. The mineral seemed richly impregnated with iron. Some of the masses presented every appearance of having been subjected to some great test of heat, as they were twisted and honey-combed into a variety of fantastic shapes. The speaker did not ascribe their igneous feature to the Indians, but to some geological agency.

The pigments are found in the cavities of the rock when broken up. They are crimson and orange, and are bright and vivid. Other shades were also observed, ranging from carmine to a delicate purple.

Fragments of paint-rock from the ancient villages along the Anacostia River were also exhibited. They were considered to be identical in composition with the specimens obtained at the quarry. With them were found paint mortars and pestles, showing plain evidences of their use.

French and Indian Half-Breeds of the Northwest.

By VICTOR HAVARD.

[Read by the Secretary.]

Surgeon Havard of the Army presented a statistical account of the *metis*, or mixed progeny of the old French *voyageurs* and the Indians. The whole number of individuals resulting from these unions amount to 32,921 for the Northwest Territory of the United States and British America.

The author gave a detailed account of the States and Territories where the *metis* are found, and described their physical and mental characteristics, as well as their arts and industries.

The author concludes while the Indian population as tribal organizations are gradually passing away, there still remains a strong infusion of Indian blood in the people of our States and Territories.

This paper will appear in the Smithsonian Report for 1879.

SEVENTH REGULAR MEETING.

JUNE 3, 1879.

Comparative Mythology of the Two Indies.

By GARRICK MALLERY.

Colonel Mallery suggested that Müller, Coxe, and some other authors on comparative mythology would have modified their ruling theories if they had possessed more knowledge of the genuine beliefs of our North American Indians. The latter have exhibited in their several stages

of savagery and barbarism, not only the repulsive details of actual fetichism, but its survival in higher forms; not only the worship of animals, and, indeed, of all imaginable forces, in explanation of phenomena, but seem, in the more advanced stages of their myths, to have mounted those loftier heights of nature-worship from which the students of Aryan records have traced the classic tales of Greece and Rome, as well as the gloomier traditions of Scandinavia. If it is true that our Indians reached what we call oriental nature-myths, out of the two successive planes of fetichism and animal worship, the popular authors may be wrong in supposing that the adoration of the sun and moon in their daily and seasonal motions was the primordial religion, and that fetichism, zoölatry and anthropomorphism appeared only in the degradation of thought and language. A thorough examination of our continent's myths shows that they contain all the pristine forms of superstition, such as ancientism, metempsychosis of man and beast, apparitions and sorcery, oracles and disease-possession; and, further, that several of the linguistic families here had begun to approach the religious plane of our own distant forefathers whose records have lately been rescued for our study by the translation of the Veda, the Zend Avesta, and Tripitaka.

Most of the earlier writers on the religion of our Indians were missionaries, who, unacquainted with the truths of evolution, applied the theory of degradation to all who differed with themselves. Convinced that their own religion was pure and natural, that is, divinely revealed, it was their object to find concordance in the cis-Atlantic faiths, also supposed to be "natural," though, for want of a written bible, not preserved in purity. Hence, all matters bearing on the religions of North America, and especially on the existence of any personal or definite God, were examined and recorded with error and distortion.

A large number of the now accurately translated myths and traditions of the Algonkian, Iroquoian, Cherokian, Muskokian, Dakotan, Tsinukan, and other families were ana-

lyzed with the result that they exhibited the essential characteristics, extending even to curiously minute details, of those traced to the prehistoric dwellers upon the foot-hills of the Hindu Kush. These resemblances in philosophy and psychology are too numerous and obvious to be merely accidental, and no theory has of late been advocated of any migration or transplanting which would satisfactorily account for them. They present an argument that the philosophy, which includes religion, of savagery and barbarism as stages in humanity, is substantially the same everywhere and at all eras of the world, and that it is neither the *débris* of some primeval universal revelation, nor the apotheosis of history, but is simply an attempt to account for such phenomena as were observed. This attempt was naturally made in a similar manner by people in like circumstances of environment and development. It may also be deduced that the nature-worship and linguistic schools of mythology are in error in attributing fetichism and zoölatry to the degradation of thought and language, as they appear to be antecedent stages from which the old Aryans had advanced beyond most of our Indians in about the same degree as they had progressed beyond them in civilization. The comprehensive study of comparative mythology shows little evidence of degeneracy, but wide-spreading and systematic evolution.

Aboriginal Cemeteries near Piscataway, Md.

BY ELMER R. REYNOLDS.

These cemeteries are situated on a low range of foot-hills between Farmington and Piscataway, in Prince George's County. Capt. Dent P. Holton was led to their discovery by finding bones exposed after a heavy rain. Upon digging, many objects are brought to light—among which are axes, arrow-heads, spear-heads, pipes, knives, coins of the time of Charles II, beads of bone, shell, amber and chalcedony,

with an occasional glass bead—also Venetian polychromes of “star pattern.” In a separate grave, probably a cache, were found a large number of finely finished quartzite knives. An ossuary was found in which were the remains of an entire family. The irregular bones were placed in the bottom and were partially destroyed by fire. The long bones were placed in the middle stratum and the crania on top.

EIGHTH REGULAR MEETING.

JUNE 17, 1879.

On the Zoological Relations of Man.

BY THEODORE GILL.

Professor Gill commenced with a notice of the views that had been entertained by naturalists and anthropologists respecting the relations of man to animals. These were very diverse and covered almost every possible ground, from the conception of the human subject as the representative of a genus collateral with others, (as by Linnæus,) to that of his exclusion from the kingdoms of nature and his reference to that of spirits (as by Swainson). Those that had found most general acceptance, however, were at first Blumenbach's and Cuvier's that man was the representative of a peculiar order adjoining that containing the apes and lemurs, and later that he was the type of a peculiar family of the order of primates collateral with the apes and monkeys of the old and new worlds.

Which of these views appears to be the most probable was the subject for consideration.

The speaker then recapitulated the most important and significant features in the morphology of man. The relative degree of value of such characteristics was next discussed,

and the successive stages of probable evolution, from the tunicate type upwards, indicated.

The conclusions from the data at hand were given as follows:

In fine, we are compelled by the force of the evidence to recognize a close relationship with the apes, and to admit the probability of our derivation in common with the Chimpanzée and Gorilla from a common ancestor, which must have been very like the latter animals. The different stages through which man was evolved and became differentiated can ever be surmised with much probability. Our pithecoïd ancestors doubtless began at length to resort, more and more, to the use of their hands for various purposes and among others for the employment of weapons of offense and defense. The shorter arms would then be more efficient than the long ones of the primitive primates and their abbreviation would therefore ensue. The more the hands were used for grasping, and discontinued for progression, the more delicate they would become. The withdrawal of the fore members from locomotion, and the continuous assumption of an erect attitude and balancing thereby would entail, among other characters, a sigmoid flexure of the vertebral column and a development of the muscles from the buttocks and calves. The same cause, in combination with the specialization of the hands, and the more exclusive use of the feet for walking and sustaining the whole body, would in time result in the parallelism of the great toe with the other. Concomitant with all these modifications would be the reduction of the canine teeth. These being, finally, comparatively little used as weapons of warfare or for procuring food, would gradually become reduced in size, and at length little protuberant beyond the others. The diastemas in the opposite jaws being then useless the same would shrink and the rows of teeth in the upper as well as the lower become continuous. There would then, also, be no need of the powerful temporal and masseter muscles, and consequently, they would shrink in size, and with them would, likewise

become atrophied the long crests to which they were attached. The result of such change would necessarily be reduction of prognathism and the vertical development of the face. The physical modifications and the intellectual would meanwhile be interacting on each other and an enlargement of the brain, and consequently, the cranial cavity would result. The form and proportions to which the anthropoid pithecoïd and pithecoïd anthropoid as well as primitive man had attained, would render a dorsal position, in rest, the most natural. The result of such a position long continued would be a decrease and ultimate disappearance of the hair on the back, and in association therewith a sparseness on the rest of the body, except on the head, wherever its use as a protection against the sun would preserve it. That on the face would be cultivated in the male as an ornament and evidence of virility. MAN would be the final product of all these agencies. The last stages in this evolution could only have taken place in a tropical country. It is probable that Africa might have been the specific one, and that from this birth-place of the human race emigration has peopled all other lands.

NINTH REGULAR MEETING.

OCTOBER 7, 1879.

An account was given by the chair, Vice President Mal-
lery, of the proceedings of the Anthropological Society of
the American Association for the Advancement of Science
at its meeting held at Saratoga, New York.

Prof. Mason gave an account of the proceedings of the
Danish Historical Society as related to the preservation of
ancient monuments. He reviewed the laws passed within
the last two or three centuries relative to the preservation of
national remains, and showed that these laws had arisen
through a desire to preserve from mutilation these records

of the ancestral people of Denmark. Formerly, he observed, the restoration and care of Danish antiquities were governed by a rude and uncertain system, through which local authorities were permitted to indulge their antiquarian taste in restoring architectural and other remains. This law, however, being subject to abuse, the Crown took entire possession of all such national monuments.

Mention was made of the unjustifiable destruction of the unique mound at Circleville, Ohio; the Kahokia mound, near St. Louis, Missouri, and other mounds in the valley of the Mississippi. He recommended and strongly urged the society to submit a memorial to Congress for the purpose of arresting the vandalism exhibited in the needless destruction of our prehistoric remains.

The chairman said that Mr. Mason's suggestion met with his hearty approval, and thought that the society ought to prepare a memorial on the subject and submit the same at an early date to the National Legislature.

Mr. Reynolds gave a brief resumé of his summer's research among the aboriginal remains on the lower waters of the Potomac. His explorations commenced in the shell-beds of King George's County, Virginia. Thence he crossed to Charles County, Maryland, and carefully examined the stupendous shell-heap and mound at the confluence of Pope's Creek and the Potomac. Subsequently he visited the site of an ancient Indian town near Centreville, in St. Mary's County, on the headquarters of the Wicomoco River. Here were found pestles, grooved axes, arrows, knives, spears, cylindrical stone beads, Venetian polychrome beads, and several spheroidal stones quite symmetrical, and found hitherto only on the Pacific Coast. During this and a subsequent visit the speaker succeeded in discovering many shell-heaps between Allen's Fresh and the mouth of the Wicomoco River.

TENTH REGULAR MEETING.

OCTOBER 21, 1879.

The Sign Language of the North American Indians.

BY GARRICK MALLERY.

The design of this paper was to illustrate the gesture-speech of mankind. After tracing its history, so far as known in other parts of the world, the theory was controverted that the power of the visible gesture relative to, and its influence upon, the audible word was inversely proportioned to the development of the oral language. The travellers' tales of people unable to understand their mother-tongue in the dark because of their inability to see the accompanying gestures, were of doubtful truth anywhere, and certainly false as regards the American tribes, many of those that gesture most freely having a copious vocabulary with highly differentiated parts of speech. The true distinction is that where the number of men speaking the same dialect is small, and when they are thrown into contact on equal terms with others of different tongues, gesture is necessarily resorted to for converse; while large bodies enjoying a common language, and either isolated from foreigners, or if in contact with them, so dominant as to compel the learning and adoption of their own tongue, become impassive in its delivery. Instances of this from the Old World were presented. But nowhere as on our continent was there spread over so vast a space so small a number of individuals, divided by so many linguistic boundaries. The general use of signs originating from the necessity for extra-tribal communication became also convenient for the habits of hunters and the military tactics of surprise. So, naturally, the practice of a sign language among our Indians is noticed by all travelers, and the assertion has been current that it was a single universal code. To test this remarkable statement a number of sign vocabularies taken in different parts of the country and at remote

dates were collected by the speaker, comprising more than eight hundred signs. The result is that there is often an entire discrepancy between the signs made by different bodies of Indians to express the same idea. Very few of the limited number of gestures that are in general use are at all conventional, being only portions more or less elaborate of obvious natural pantomime; and those proving to be the fittest expressions of the several ideas become the most widely adopted. In some cases the original air pictures of an outline or action have become abbreviated; and even if both the original conception and delineation were at first the same, the two or more abbreviations become unlike. The first conceptions were also often diverse, because all objects have several characteristics, and what strikes one set of people as the most distinctive will not always so impress another.

The speaker gave from the collected lists, or vocabularies, a large number of examples where either the conception or execution, or both, to express the same idea are widely diverse. Also a number of typical cases of agreement, followed by illustrations of others not remarkable either for general or limited acceptance, but for the philosophy or poetry suggested by their picturesque figuration. Some of these were compared with the gestures of savage and civilized people in the Old World; with those of deaf mutes; with the code of the Cistercian monks, who were vowed to silence; and with the picture writing on buffalo robes and on Egyptian pyramids. The general result proved that there was no uniformity in detail, but the variety in expression was in itself of great psychological interest. While the assertion of a single universal sign-language among the tribes is, therefore, one of the popular errors about our aborigines, it is, nevertheless true, that the attempt to convey meaning by signs is universal among them; and further, two intelligent pantomimists, whether Indian or Caucasian, deaf-mute, or without common tongue, will seldom fail of mutual understanding when their attention is exclusively

directed to expressing thoughts by means of comprehension and reply equally possessed by both, without the mental confusion of conventional sounds only intelligible to one.

ELEVENTH REGULAR MEETING.

NOVEMBER 4, 1879.

Poisoned Weapons of North and South America.

By W. J. HOFFMAN.

This paper was an historical review of the accounts which various travelers and writers have given of the use of poisoned weapons and the antidotes therefor, discovered in North and South America.

The Use of Agricultural Fertilizers by the American Indians and the Early English Colonists.

By G. BROWN GOODE.

This paper has been published in full in the *American Naturalist* for July, 1880.

TWELFTH REGULAR MEETING.

NOVEMBER 18, 1879.

A Comparison of a Written Language With One That is Spoken Only.

By OTIS T. MASON.

The Rev. Cyrus Byington, in the introductory chapter of his Chata (Choctaw) Grammar, draws attention to the fact that this is merely a spoken language, and must not be gauged by the ordinary critical tests of a written language.

This observation led the speaker to inquire what are the essential differences between a language merely spoken and one that is also written.

In a spoken language there are two agents at work, the speaker and the hearer. The former is the creator of language, as well as its progressive or destructive agent. The latter is the preserver of language, being its conservative and defensive agent. It is evident that a language at any period of its history is a compromise between these two opposing forces. Again, the amount of usefulness in a purely spoken language must be exceedingly limited, being measured by the ability of its conservators to remember what is said, in conjunction with the manner of saying it. The compass of such a speech, the definiteness and variety of expression, must be exceedingly circumscribed.

When we combine the writer and the reader with the speaker and the hearer, we have four forces in place of two; we add another aggressive and another conservative agency, and the status of the language at any period will be a compromise of a more intricate character. The aggressiveness of the writer is generally much less than that of the speaker, and also the preservative power of written language is immensely greater than that of pure memory among a people without writing. We ought to find, therefore, that the invention of the art of writing has had a tendency to place speech upon a more stable basis. The invention of the written symbol is itself a confession of the inadequacy of the old method, and would never have taken place if the improved status in culture had not called loudly for linguistic facilities which speech alone did not furnish.

Again, the means of retaining before the mind a great number of facts leads to the improvement of observation and classification, the readjustment of the categories of thought, and, consequently, the recompounding of words upon a more scientific basis. The chief improvement, however, is in the sentence. The spoken thought is but breath "that fits ere you can point its place;" but the written sentence is like

the painter's canvas, ever on the easel, and may be retouched at any moment, even after the death of its author. This fact leads to the differentiation of the parts of speech, enables a people to increase the number of sentential functions, and to define their limits; to vary the composition and collocation of the terms which express these functions; to answer the demands of rigid logic by a better separation of subject, predicate, and modifier; and, finally, to add strength and beauty to mere utterance by an infinite variety of purely rhetorical devices.

There is no doubt that writing, in addition to being the vehicle and instrument of thought, is itself a factor in the problem of civilization, not only borrowing its improved form from an improved culture, but itself reciprocating the favor in contributing to human advancement.

On the Aboriginal Shell-heaps at Pope's Creek, Maryland.

By ELMER R. REYNOLDS.

Mr. Reynolds discovered these shell-heaps in 1878. They are sixty miles south of Washington, at the confluence of Pope's Creek and the Potomac River, in Charles County, Maryland. They are situated within the territory of the Yoacomico Indians, whose headquarters were near the present site of St. Mary's, south of Wicomico River. An account of these Indians may be found in Father White's *Relatio Itineris in Marylandiam*. Between 1634 and 1640 the Yoacomico Indians ceded their land to the Colony of St. Mary's, after which they gradually disappeared as a tribe, although many of their descendants remain near Allen's Fresh, Port Tobacco, and Nanjemoy.

There are two of these shell-heaps, the larger one lying on the north side of the creek, and the smaller, but more interesting one, on the south side. In the former the shells occupy the summit of a hill about 25 feet above tide-water

and 300 feet long. The bank is from 3 to 5 feet in depth on the creek, but becomes more and more shallow and extended laterally until it is lost in the surrounding fields.

The southern shell-heap rests on a lower spur of the hills which bound the creek. It is probably about 150 feet long, 100 feet wide, and 4 feet deep. These dimensions are roughly estimated, as, owing to an overlying stratum of earth from 2 to 24 inches in thickness, accurate measurements are difficult.

Both of these banks are composed of oyster-shells, in many places packed together. Although they are undoubtedly of pre-Columbian origin, there is nothing to indicate a very high antiquity. From the absence of broken shells in any great numbers, it seems probable that the oysters were steamed or roasted before they were removed from the shells.

The contents of the heaps were a few bones of the turtle and of the deer, rudely flaked arrow-heads, axes and celts, hammer-stones, and pottery. Many of these objects also occur on the surface, and seem to be more highly finished than those of the shell-heaps.

The earthenware belongs to the class known as basket-pottery, and shows the meshes of the rush moulds in which the vessels were formed. The fragments recovered are nearly an inch in thickness, and in several instances flaked and blistered by the long-continued action of fire. The ornamentation is in intaglio, and presents the endless variety of curves and chevrons which we are accustomed to see on ware of this class.

The author discusses in the course of his remarks the question of the disappearance and reappearance of oysters in certain localities in connection with the occurrence of the signs of stratification in the shell-heaps.

THIRTEENTH REGULAR MEETING.

DECEMBER 2, 1879.

Ancient Maps of North America.

BY JOHN C. LANG.

Maps bear the same relation to the history of geographic discovery that portraits do to biography. Historians find in charts of the early explorers historical documents easily interpreted and needing no translation.

The old writer or geographer who has given us a map has furnished us a check on his verbal report. Even the compiler of a map cannot hide from us the sources of his information. As in a hall of statuary we may recognize casts from antique marbles, so upon the map we can identify and separate, if need be, the work of many hands.

But few of the cartographic representations of the early discoverers in the New World exist. It would take less time to describe the historical maps to which we can now refer, than to mention those which we know to have perished. Columbus came of a family of map-makers, and was himself an experienced cartographer, and for years carried on the work of constructing charts for sale. Previous to his memorable voyages he was doubtless an enthusiastic collector of geographic information from every available source.

In February, 1467, he visited Iceland, to examine into the facts touching upon the discoveries of the Northmen, and while there it is probable that he searched the whole range of documents necessary to his subject. At that time he was probably able to find those who remembered the visits of the Zeri Brothers, who three-fourths of a century previous had compiled from the Norse records a complete map of the coast discovered and colonized by the Norsemen three hundred years before.

Mr. Lang then presented a series of maps, published from 1436 to 1513, and by crayon sketches illustrated the progress of geographic discovery of the coast of North and South America, as exhibited in said series.

On the Effacing Power of tropical Forest-growth in Trinidad Island.

By MILES ROCK.

Columbus discovered this island in 1498. In the year 1588 the Spaniards made the settlement of Saint Joseph, on the river Maracas, an affluent of the Caroni, which empties into the Gulf of Paria near the modern city of Port of Spain. Instead of entering the Gulf of Paria and passing up the valley of the Caroni, they moored their vessels in the little bay of Las Cuevas on the north side of the island, and crossed the mountains over a pass that rises to the height of 2,000 feet in four miles. The road passes on one side of the highest peak in the island, Tucuche, or Eagle's Beak, which rises 1,000 feet above the pass and seems almost vertical.

On the other side they descended and followed the Maracas River to the last foot-hills, where they beheld the plain of Caroni. Here they built the settlement of Saint Joseph.

The road over the mountain, though seldom used now, by the great amount of travel in former times was deeply worn and is now quite passable.

While laboring through the thick forests on the cape east of Las Cuevas Bay, Mr. Rock and his party stumbled upon some rusty iron cannon protruding above the ground. On this rocky headland, therefore, commanding the entrance to the bay, the Spaniards had a fort. The tropical forest has overwhelmed every vestige of its existence. With a little care it was possible to trace where a settlement had existed back of the fort. A few mango trees survive of all that once constituted this station.

The pass is still called "La Ventana," because on the way from the bay you are immersed in the sombre forest; but on reaching the top a magnificent vista of mountain, forest, and sea lies at the feet.

In 1676 the French took possession of the island and held it until 1797, when it fell into the hands of the British. By this time Port of Spain had replaced St. Joseph, and the latter was buried in the common forest growth.

Not over fifty years ago Las Cuevas was a sugar plantation. It was then abandoned and remained uncultivated until a few years since, when it was bought for a cocoa orchard. Everywhere an impenetrable forest shut out the sun, and no evidence could be found that it had been the abode of man.

On the Determination of the Age of Prehistoric Remains.

By EDWARD P. LULL.

To illustrate the caution that should be exercised in estimating the age of prehistoric remains from their state of decay and the appearance of the covering of earth, vegetable growth and forests, Commander Lull gave an account of some observations made by himself of the remains of a Scottish Colony, established by Pattison at Caledonia Bay, Isthmus of Darien, and which was abandoned early in the last century.

A large area on Point Escoses, occupied and fortified by the colonists, was enclosed on the inshore side by a moat excavated in rock. Thanks to the latter fact, it is distinctly traceable. The enclosed space is not only heavily timbered with exogenous trees of numerous kinds, but many of the trees have decayed and fallen. One end of the moat for an eighth of a mile, or more, is completely filled with logs and other *débris*. No difficulty was found in wading through the remaining portions. The moat being, as stated, cut through the soil and into the bed-rock offered an efficient

barrier to the spread of vegetation from the adjacent forest or the transportation of material from the same source by the wash of rains. The soil, thin as it is, probably contained a very large share of the germs which have since developed; while the wind, the birds and other animals have lent their constant aid for what further was needed. At the present time there is no vestige of this ancient work save the moat, and looking at a like heavy growth of timber in a northern climate, no doubt would be entertained that it was a forest of great age.

Just in rear of the city of Cartagena, U. S. of Colombia, there is a hill, some three hundred feet in elevation, surmounted by a castle that was one of the principal defences of the city less than half a century ago. The hillsides are now completely and heavily overgrown with a matted tangle of trees, vines, and parasites, so much so that a party attempting in 1871 to climb the hill, were obliged, with no little labor, to cut a pathway with the vigorous use of machetas, and were told by the inhabitants that no one had attempted the ascent before for years. The castle, like the city itself, with its fortified walls, its magnificent palaces, churches, and convents, monuments of the skill, energy, and lavish expenditure of the Spanish builders, is rapidly falling into ruins, and is one of the many examples of the extremely rapid progress in tropical America of the decay of the strongest works, and heaviest masonry, when left without proper care, especially exhibiting the heaving effect of vegetable growth. Woodwork has two enemies—the rapid alternation of moisture and burning sunshine, and boring insects—the latter being almost as destructive as the *teredo navalis*, though requiring a longer time for their work. The present occupants of the land make little or no effort to arrest the progress of destruction, and Porto Bello is almost as complete a ruin as Pompeii, notwithstanding the very short time that has elapsed since it was a wealthy and populous town.

The rapid accumulation of strata in localities favorably situated, and the growth of cottonwood groves on the banks

of the Mississippi river are familiar to many. The speaker had occasion the previous winter to visit several places near the mouth of the Red River where he had served, fourteen years before, during the civil war. In one place, where vessels were anchored at the earlier date, an island had formed some rods in width, leaving a little channel between itself and the main shore, and was covered with a growth of cottonwood trees at least half as large as those of the adjacent forest. At Morganzia a large field was occupied for two or three years by troops as a camp, and was not only stripped of every tree, but was broken down by the constant march of men and teams, so that the soil must have been in a rather unfavorable condition. It was scarcely recognizable, the old camp-ground being entirely covered with trees as large as any others in the vicinity. From such observations, the speaker was led to conclude that evidences of antiquity derived from forest growth and other changes in topographic characteristics were apt to mislead archæologists.

Mr. Riley read a letter from a correspondent in San Antonio, Texas, relating to the discovery of a remarkable cave in a mountain standing in the valley of the Rio Nazas, state of Durango, Mexico. This river empties into a *laguna*, or inland sea, ninety miles long and thirty miles wide, with an elevation of about 3,000 feet above tide water; it has no outlet. The mountain in which the burial cave is found, stands near the shore of the lake. The cave is of great extent and contains hundreds of mummies, representing a distinct race of Indians of whom no history or tradition exists. Each mummy is carefully wrapped in a blanket, or mat made of the leaves of the Maquez plant and gorgeously colored with dyes and paints. The remains are in an excellent state of preservation—the hair perfect, the flesh seems to have become dessicated, or dried to the bones with no trace of decomposition. No implements of metal were found, but there was a profusion of arrows, spears, and and knives, made of stone. The pottery showed a high

degree of art. The vessels were large and bore a close resemblance to the decorated pottery of ancient Egypt.

FOURTEENTH REGULAR MEETING.

DECEMBER 16, 1879.

The President read the folk story of the "Tar Baby" from a copy of the *Evening Star* of Washington, D. C., and stated that he had found the same, modified in different ways, among many Indian tribes.

He also related the Indian story of the "Three Cranberries," which has an extensive circulation among the tribes of North America. In the latter story the moral is, "To escape from wolves you must climb a tree."

Turtle-Back Celts and their Uses.

By ELMER R. REYNOLDS.

The class of implements known as turtle-back celts were first mentioned by Dr. Charles Abbott in the Smithsonian annual report for 1875, and more fully described in the tenth and eleventh annual reports of the Peabody Museum.

Mr. Reynolds, in answer to Dr. Abbott's hypothesis that "each celt combines in itself a knife, a celt, and a spear," recounted his own experience in the discovery of these implements.

The objects exhibited and described were found on the site of an old Indian village, near Benning's Bridge, in the District of Columbia, where at least ten thousand other relics have been collected.

The material of the celts is a metamorphosed new red sandstone, the color having changed to a bluish grey.

In form the "turtle-backs" differ greatly from the ordinary chipped celt. The base or head of the former is where we find the blade or cutting-edge of the latter, while the head or posterior projection of the common type corresponds to the blade of the "turtle-back." The former is perfectly flat on the inferior face, the upper side being flaked into the form which its name indicates, but the chipped celt is beveled and evenly finished on both sides, so that, if it were possible to split it laterally, two "turtle-back" celts would result.

From a comparison of their form with that of many implements now and formerly known to be in use among the Indians, Mr. Reynolds concluded that these implements were hafted in the manner of a stone adze, and employed principally in excavating dug-out canoes. It was not denied that they may have been employed in all the multifarious processes to which the fertile brain of the Indian enables him to supply his scanty store of implements.

The author adverted to the canoes of the northwest coast and the sea-faring proas of the New Zealanders made with stone implements and with the help of fire.

Specimens of the "turtle-back" celts were exhibited by the speaker, some of them hafted, in order to show the design of their peculiar form. The flat side doubtless, lay against the wooden handle, and the projection on the back would impart the greatest possible strength at the very point where it was most needed.

FIFTEENTH REGULAR MEETING.

JANUARY 6, 1880.

Shell-Heaps of South River, Maryland.

By J. D. McGUIRE.

Wherever shell-fish are found in salt or fresh waters, the lands adjacent thereto bear evidences that shell-fish were used by primitive men as articles of food.

This statement was illustrated by an enumeration of the discoveries of archæologists in Australia, New Zealand, Europe, and North and South America.

The speaker made mention of the opinions entertained by different writers in relation to the origin of the shell-heaps of the Atlantic coast and enumerated the facts by which archæologists had reached the conclusion that these shell-heaps are in reality accumulations of kitchen refuse made by the ancient inhabitants of the shores.

Mr. McGuire then gave an account of the shell-heaps examined by himself. Usually the smaller are circular or elliptical rings from twelve to fifteen feet in diameter, and show plainly that they are the sites of former dwellings. The centre of each ring is always depressed and represents an inverted cone. Upon a trench through one of these heaps there is found a level substratum of earth, but the shells increase in depth as the ridge is approached. This is sometimes four or five feet high; then they decrease in depth as the centre of the ring is reached. These rings seem to have been formed by throwing the shells from a common centre.

To account for the peculiar shape of these deposits it is necessary to consider the construction of the Indian house. There is historical evidence showing that it was made of poles with the large ends on the ground in a circle, and bound at the top with the bark of the walnut tree, and the whole covered with sedge matting sewed with a needle made of the splintered bone of a crow's leg. Doorways were covered by movable mats. His theory was that the shells thrown from such a house would gradually accumulate, forming a circular wall. When the houses were finally deserted, the action of the weather would reduce the shell wall on the exterior to the condition in which these heaps are found.

Other shell-heaps discovered by Mr. McGuire were supposed to be accumulations about large communal dwellings. In general outline they are elliptical. Low spaces

in the encircling ridge mark the sites of entrances, and hearthstones are found in the central spaces. In all the heaps examined the shells are rarely found broken. The inference was drawn that the shells had been opened after having been placed near the fire, or in hot water, so that they could be parted with the hands without the use of an instrument.

Most of the bones found had been broken, probably for the purpose of extracting the marrow. A few bone tools were found, and many fragments of pottery.

ANNUAL MEETING FOR THE ELECTION OF OFFICERS.

JANUARY 20, 1880.

A Strange Chart.

BY W. BAINBRIDGE HOFF.

Commander Hoff stated that in 1869 he was shown a chart in the Naval Arsenal, Lisbon, Portugal, that had sufficient novelty about it to be worthy of special mention.

It represented the Indian and Pacific oceans lying between, say 30° N. and 36° S. latitude, and extending sufficiently in longitude to embrace the eastern African and Asiatic coasts and the western coast of America. It had been prepared by a Spanish Jesuit, who dedicated the chart to "Jesus Christ the Master of the World," and had preceded his signature with a prayer. The text was in Latin, and the date of the chart was somewhere in the first quarter of the seventeenth century.

The extraordinary feature of this map was that geographic positions had seemingly been laid down at random, and that any correction for latitude and longitude applied to any one point did not answer for another. Nearly all the results of late discovery were on this chart, but entirely adrift in position. This would lead to the belief that the chart had been intentionally distorted—and this proved to be the case.

The map in question was constructed upon Mercator's projection, but instead of the parallels and meridians being straight lines at right angles to one another, they were arbitrarily-drawn curves. It was of course necessary to have a key to this chart, which, upon being furnished, proved to be very elaborate. Besides giving proper diagrams of the arbitrary lines, it gives the *constants* to be applied to individual localities and their corrected latitudes and longitudes. On the chart itself was a *cryptographic* statement of the necessary *formulæ* for constructing the curves geometrically, referred to the N. E.-S. W. and N. W.-S. E. points of the compass as axes.

ANNUAL ADDRESS OF THE PRESIDENT,

J. W. POWELL.

ON THE EVOLUTION OF LANGUAGE,

As Exhibited in the Specialization of the Grammatic Processes, the Differentiation of the Parts of Speech, and the Integration of the Sentence; from a Study of Indian Languages.

Possible ideas and thoughts are vast in number. A distinct word for every distinct idea and thought would require a vast vocabulary. The problem in language is to express many ideas and thoughts with comparatively few words.

Again, in the evolution of any language, progress is from a condition where few ideas are expressed by a few words to a higher, where many ideas are expressed by the use of many words; but the number of all possible ideas or thoughts expressed is increased greatly out of proportion with the increase of the number of words.

And still again, in all of those languages which have been most thoroughly studied, and by inference in all languages, it appears that the few original words used in any language remain as the elements for the greater number finally used. In the evolution of a language the introduction of absolutely new material is a comparatively rare phenomenon. The old material is combined and modified in many ways to form the new.

How has the small stock of words found as the basis of a language been thus combined and modified?

The way in which the old materials have been used giving rise to what will here be denominated THE GRAMMATIC PROCESSES. They are as follows:

I. The process by COMBINATION. Two or more words may be united to form a new one, or to perform the office of a new one, and four methods or stages of combination may be noted:

a. By *juxtaposition*, where the two words are placed together and yet remain as distinct words. This method is illustrated in Chinese, where the words in the combination when taken alone seldom give a clew to their meaning when placed together.

b. By *compounding*, where two words are made into one, in which case the original elements of the new word remain in an unmodified condition, as in "house-top," "rain-bow," "tell-tale."

c. By *agglutination*, in which case one or more of the elements entering into combination to form the new word is somewhat changed—the elements are fused together. Yet this modification is not so great as to essentially obscure the primitive words, as in "truthful," where we easily recognize the original words "truth" and "full;" and "holiday," in which "holy" and "day" are recognized.

d. By *inflection*. Here one or more of the elements entering into the compound has been so changed that it can scarcely be recognized. There is a constant tendency to economy in speech by which words are gradually shortened as they are spoken by generation after generation. In those words which are combinations of others there are certain elements that wear out more rapidly than others. Where some particular word is combined with many other different words the tendency to modify by wear this oft-used element is great. This is more especially the case where the combined word is used in certain categories of combinations, as where particular words are used to denote tense in the verb; thus, "did" may be used in combination with a verb to denote past time until it is worn down to the sound of "d."

The same wear occurs where particular words are used to form cases in nouns, and a variety of illustrations might be given. These categories constitute conjugations and declensions, and for convenience such combinations may be called paradigmatic. Then the oft-repeated elements of paradigmatic combinations are apt to become excessively worn and modified, so that the primitive words or themes to which they are attached seem to be but slightly changed by the addition. Under these circumstances combination is called inflection.

As a morphologic process, no well-defined plane of demarcation between these four methods of combination can be drawn, as one runs into another; but, in general, words may be said to be juxtaposed, when two words being placed together the combination performs the function of a new word, while in form the two words remain separate.

Words may be said to be compound when two or more words are combined to form one, no change being made in either. Words may be said to be agglutinated when the elementary words are changed but slightly, *i. e.*, only to the extent that their original forms are not greatly obscured; and words may be said to be inflected when in the combination the oft-repeated element or formative part has been so changed that its origin is obscured. These inflections are used chiefly in the paradigmatic combinations.

In the preceding statement it has been assumed that there can be recognized, in these combinations of inflection, a theme or root, as it is sometimes called, and a formative element. The formative element is used with a great many different words to define or qualify them, that is to indicate mode, tense, number, person, gender, etc., of verbs, nouns, and other parts of speech.

When in a language juxtaposition is the chief method of combination, there may also be distinguished two kinds of elements, in some sense corresponding to themes and formative parts. The theme is a word the meaning of which is determined by the formative word placed by it; that is, the

theme is a word having many radically different meanings; with which meaning it is to be understood is determined only by the formative word, which thus serves as its label. The ways in which the theme words are thus labeled by the formative word are very curious, but the subject cannot be entered into here.

When words are combined by compounding, the formative elements cannot so readily be distinguished from the theme; nor for the purposes under immediate consideration can compounding be well separated from agglutination.

When words are combined by agglutination, theme and formative part usually appear. The formative parts are affixes; and affixes may be divided into three classes, prefixes, suffixes, and infixes. These affixes are often called incorporated particles.

In those Indian languages where combination is chiefly by agglutination, that is, by the use of affixes, *i. e.*, incorporated particles, certain parts of the conjugation of the verb, especially those which denote gender, number and person, are effected by the use of article pronouns; but in those languages where article pronouns are not found the verbs are inflected to accomplish the same part of their conjugation. Perhaps, when we come more fully to study the formative elements in these more highly inflected languages, we may discover in such elements greatly modified, *i. e.*, worn out, incorporated pronouns.

II. The process by VOCALIC MUTATION. Here in order to form a new word, one or more of the vowels of the old word are changed, as in "man"—"men," where an "e" is substituted for "a"; "ran"—"run," where "u" is substituted for "a"; "lead"—"led," where "e," with its proper sound, is substituted for "ea" with its proper sound. This method is used to a very limited extent in English. When the history of the words in which it occurs is studied it is discovered to be but an instance of the wearing out of the different elements of combined words; but in the Hebrew this method prevails to a very large extent, and scholars have not yet been able

to discover its origin in combination as they have in English. It may or may not have been an original grammatic process, but because of its importance in certain languages it has been found necessary to deal with it as a distinct and original process.

III. The process by INTONATION. In English, new words are not formed by this method, yet words are intoned for certain purposes, chiefly rhetorical. We use the rising intonation (or inflection, as it is usually called) to indicate that a question is asked, and various effects are given to speech by the various intonations of rhetoric. But this process is used in other languages to form new words with which to express new ideas. In Chinese eight distinct intonations are found, by the use of which one word may be made to express eight different ideas, or perhaps it is better to say that eight words may be made of one.

IV. The process by PLACEMENT. The place or position of a word may affect its significant use. Thus in English we say "John struck James." By the position of those words to each other we know that John is the actor, and that James receives the action.

By the grammatic processes language is organized. Organization postulates the differentiation of organs and their combination into integers. The integers of language are sentences, and their organs are the parts of speech. Linguistic organization, then, consists in the differentiation of the parts of speech and the integration of the sentence. For example, let us take the words *John*, *father*, and *love*. John is the name of an individual; love is the name of a mental action, and father the name of a person. We put them together, John loves father, and they express a thought; *John* becomes a noun, and is the subject of the sentences; *love* becomes a verb, and is the predicator; *father* a noun, and is the object; and we now have an organized sentence. A sentence requires parts of speech, and parts of speech are such because they are used as the organic elements of a sentence.

The criteria of rank in languages are, first, grade of organization, *i. e.*, the degree to which the grammatic processes and methods are specialized, and the parts of speech differentiated; second, sematologic content, that is, the body of thought which the language is competent to convey.

The grammatic processes may be used for three purposes:

First, for *derivation*, where a new word to express a new idea is made by combining two or more old words, or by changing the vowel of one word, or by changing the intonation of one word.

Second, for *modification*, a word may be qualified or defined by the processes of combination, vocalic mutation or intonation.

It should here be noted that the plane between derivation and qualification is not absolute.

Third, for *relation*. When words as signs of ideas are used together to express thought the relation of the words must be expressed by some means. In English the relation of words is expressed both by placement and combination, *i. e.*, inflection for agreement.

It should here be noted that paradigmatic inflections are used for two distinct purposes, qualification and relation. A word is qualified by inflection when the idea expressed by the inflection pertains to the idea expressed by the word inflected; thus a noun is qualified by inflection when its number and gender are expressed. A word is related by inflection when the office of the word in the sentence is pointed out thereby; thus, nouns are related by case inflections; verbs are related by inflections for gender, number, and person. All inflection for agreement is inflection for relation.

In English, the three grammatic processes are highly specialized.

Combination is used chiefly for derivation, but to some slight extent for qualification and relation in the paradigmatic categories. But its use in this manner as compared with many other languages has almost disappeared.

Vocalic mutation is used to a very limited extent and only by accident, and can scarcely be said to belong to the English language.

Intonation is used as a grammatic process only to a limited extent—simply to assist in forming the interrogative and imperative modes. Its use here is almost rhetorical; in all other cases it is purely rhetorical.

Placement is largely used in the language, and is highly specialized, performing the office of exhibiting the relations of words to each other in the sentence, *i. e.*, it is used chiefly for syntactic relation.

Thus one of the four processes does not belong to the English language; the others are highly specialized.

The purposes for which the processes are used are *derivation*, *modification*, and *syntactic relation*.

Derivation is accomplished by combination.

Modification is accomplished by the differentiation of adjectives and adverbs, as words, phrases, and clauses.

Syntactic relation is accomplishment by placement. *Syntactic relation* must not be confounded with the relation expressed by prepositions. Syntactic relation is the relation of the parts of speech to each other as integral parts of a sentence. Prepositions express relations of thought of another order. They relate words to each other as words.

Placement relates words to each other as parts of speech.

In the Indian tongues combination is used for all three purposes, performing the three different functions of derivation, modification, and relation. Placement also is used for relation, and for both kinds of relation, syntactic and prepositional.

With regard, then, to the processes and purposes for which they are used we find in the Indian languages a low degree of specialization; processes are used for diverse purposes, and purposes are accomplished by diverse processes.

It is next in order to consider to what degree the parts of speech are differentiated in Indian language, as compared with English.

Indian nouns are extremely connotive, that is, the name does more than simply denote the thing to which it belongs; in denoting the object it also assigns to it some quality or characteristic. Every object has many qualities and characteristics, and by describing but a part of these the true office of the noun is but imperfectly performed. A strictly denotive name expresses no one quality or character, but embraces all qualities and characters.

In Ute the name for bear is "he seizes," or "the hugger." In this case the verb is used for the noun, and in so doing the Indian names the bear by predicating one of his characteristics. Thus noun and verb are undifferentiated. In Seneca the north is "the sun never goes there," and this sentence may be used as adjective or noun; in such cases noun, adjective, verb, and adverb are found as one vocable or word, and the four parts of speech are undifferentiated. In the Pavänt language a school-house is called Pó-künt-în-îñ-yî-kän. The first part of the word, pó-künt, signifies "sorcery is practiced," and is the name given by the Indians to any writing from the fact that when they first learned of writing they supposed it to be a method of practicing sorcery; îñ-ing-yî is the verb signifying "to count," and the meaning of the word has been extended so as to signify "to read"; "kän" signifies wigwam, and is derived from the verb "käri," "to stay." Thus the name of the school-house literally signifies "a staying place where sorcery is counted," or where papers are read. The Pavänt in naming a school-house describes the purpose for which it is used. These examples illustrate the general characteristics of Indian nouns; they are excessively connotive; a simply denotive name is rarely found. In general their name-words predicate some attribute of the object named, and thus noun, adjective, and predicant are undifferentiated.

In many Indian languages there is no separate word for eye, hand, arm, or other parts and organs of the body, but the word is found with an incorporated or attached pronoun signifying *my* hand, *my* eye; *your* hand, *your* eye, *his* hand,

his eye, &c., as the case may be. If the Indian, in naming these parts, refers to his own body, he says *my*; if he refers to the body of the person to whom he is speaking, he says *your*, &c. If an Indian should find a detached foot thrown from the amputating-table of an army field hospital, he would say something like this: "I have found somebody *his* foot." The linguistic characteristic is widely spread, though not universal.

Thus the Indian has no command of a fully differentiated noun expressive of "eye," "hand," "arm," or other parts and organs of the body.

In the pronouns we often have the most difficult part of an Indian language. Pronouns are only to a limited extent independent words.

Among the free pronouns the student must early learn to distinguish between the personal and the demonstrative. The demonstrative pronouns are more commonly used. The Indian is more accustomed to say *this* person or thing, *that* person or thing, than *he*, *she*, or *it*. Among the free personal pronouns the student may find an equivalent of the pronoun "I," another signifying "I and you;" perhaps another signifying "I and he," and one signifying "we," more than two, including the speaker and those present; and another including the speaker and persons absent. He will also find personal pronouns in the second and third person, perhaps with singular, dual, and plural forms.

To a large extent the pronouns are incorporated in the verbs as prefixes, infixes, or suffixes. In such cases we will call them article pronouns. These article pronouns point out with great particularity the person, number, and gender, both of subject and object, and sometimes of the indirect object. When the article pronouns are used the personal pronouns may or may not be used; but it is believed that the personal pronouns will always be found. Article pronouns may not always be found. In those languages which are characterized by them they are used alike when the subject and object nouns are expressed and when they are

not. The student may at first find some difficulty with these article pronouns. Singular, dual, and plural forms will be found. Sometimes distinct incorporated particles will be used for subject and object, but often this will not be the case. If the subject only is expressed, one particle may be used ; if the object only is expressed, another particle ; but if subject and object are expressed an entirely different particle may stand for both.

But it is in the genders of these article pronouns that the greatest difficulty may be found. The student must entirely free his mind of the idea that gender is simply a distinction of sex. In Indian tongues, genders are usually methods of classification primarily into animate and inanimate. The animate may be again divided into male and female, but this is rarely the case. Often by these genders all objects are classified characteristics found in their attitudes or supposed constitution. Thus we may have the animate and inanimate, one or both, divided into the *standing*, the *sitting*, and the *lying* ; or they may be divided into the *watery*, the *mushy*, the *earthy*, the *stony*, the *woody*, and the *fleshy*. The gender of these article pronouns has rarely been worked out in any language. The extent to which these classifications enter into the article pronouns is not well known. The subject requires more thorough study. These incorporated particles are here called *article* pronouns. In the conjugation of the verb they take an important part, and have by some writers been called *transitions*. Beside pointing out with particularity the person, number, and gender, or the subject and object, they perform the same offices that are usually performed by those inflections of the verb that occur to make them agree in gender, number, and person with the subject. In those Indian languages where the article pronouns are not found, and the personal pronouns only are used, the verb is usually inflected to agree with the subject or object, or both, in the same particulars.

The article pronouns as they point out person, number, gender, and case of the subject and object, are not simple

particles, but are to a greater or lesser extent compound; their omnipotent elements may be broken apart and placed in different parts of the verb. Again, the article pronoun in some languages may have its elements combined into a distinct word in such a manner that it will not be incorporated in the verb, but will be placed immediately before it. For this reason the term "article pronoun" has been chosen rather than "attached pronoun." The older term, transition, was given to them because of their analogy in function to verbal inflections.

Thus the verb of an Indian language contains within itself incorporated article pronouns which point out with great particularity the gender, number, and person of the subject and object. In this manner verb, pronoun, and adjective are combined, and to this extent these parts of speech are undifferentiated.

In some languages the article pronoun constitutes a distinct word, but whether free or incorporated it is a complex tissue of adjectives.

Again, nouns sometimes contain particles within themselves to predicate possession, and to this extent nouns and verbs are undifferentiated.

The verb is relatively of much greater importance in an Indian tongue than in a civilized language. To a large extent the pronoun is incorporated in the verb as explained above, and thus constitutes a part of its conjugation.

Again, adjectives are used as intransitive verbs, as in most Indian languages there is no verb "to be" used as a predicant or copula. Where in English we would say "the man is good," the Indian would say "that man good," using the adjective as an intransitive verb, *i. e.*, as a predicant. If he desired to affirm it in the past tense, the intransitive verb "good" would be inflected, or otherwise modified, to indicate the tense; and so, in like manner, all adjectives when used to predicate can be modified to indicate mode, tense, number, person, &c., as other intransitive verbs.

Adverbs are used as intransitive verbs. In English we

may say "he is there;" the Indian would say "that person there," usually preferring the demonstrative to the personal pronoun. The adverb "there" would, therefore, be used as a predicant or intransitive verb, and might be conjugated to denote different modes, tenses, numbers, persons, &c. Verbs will often receive adverbial qualifications by the use of incorporated particles, and still further, verbs may contain within themselves adverbial limitations without our being able to trace such meanings to any definite particles or parts of the verb.

Prepositions are intransitive verbs. In English we may say "the hat is on the table;" the Indian would say "that hat on table;" or he might change the order and say "that hat table on;" but the preposition "on" would be used as an intransitive verb to predicate, and may be conjugated. Prepositions may often be found as particles incorporated in verbs, and still further, verbs may contain within themselves prepositional meanings without our being able to trace such meanings to any definite particles within the verb. But the verb connotes such ideas that something is needed to complete its meaning, that something being a limiting or qualifying word, phrase, or clause. Prepositions may be prefixed, infixed, or suffixed to nouns; *i. e.*, they may be particles incorporated in nouns.

Nouns may be used as intransitive verbs under the circumstances when in English we would use a noun as the complement of a sentence after the verb "to be."

The verb, therefore, often includes within itself subject, direct object, indirect object, qualifier, and relation-idea. Thus it is that the study of an Indian language is, to a large extent, the study of its verbs.

Thus adjectives, adverbs, prepositions, and nouns are used as intransitive verbs; and, to such extent, adjectives, adverbs, prepositions, nouns, and verbs are undifferentiated.

From the remarks above, it will be seen that Indian verbs often include within themselves meanings which in English are expressed by adverbs and adverbial phrases and clauses.

Thus the verb may express within itself direction, manner, instrument, and purpose, one or all, as the verb "to go" may be represented by a word signifying "go home"; another, "go away from home"; another, "go to a place other than home"; another, "go from a place other than home"; one, "go from this place," without reference to home; one, "to go up"; another, "to go down"; one, "go around"; and, perhaps, there will be a verb "go up-hill"; another, "go up a valley"; another, "go up a river," &c. Then we may have "to go on foot," "to go on horseback," "to go in a canoe"; still another, "to go for water;" another, "for wood," &c. Distinct words may be used for all these, or a fewer number used, and these varied by incorporated particles. In like manner, the English verb "to break" may be represented by several words, each of which will indicate the manner of performing the act or the instrument with which it is done. Distinct words may be used, or a common word varied with incorporated particles.

The verb "to strike" may be represented by several words, signifying severally "to strike with the fist," "to strike with a club," "to strike with the open hand," "to strike with a whip," "to strike with a switch," "to strike with a flat instrument," &c. A common word may be used with incorporated particles or entirely different words used.

Mode in an Indian tongue is a rather difficult subject. Modes analogous to those of civilized tongues are found, and many conditions and qualifications appear in the verb which in English and other civilized languages appear as adverbs, and adverbial phrases and clauses. No plane of separation can be drawn between such adverbial qualifications and true modes. Thus there may be a form of the verb which shows that the speaker makes a declaration as certain, *i. e.*, an *indicative* mode; another which shows that the speaker makes a declaration with doubt, *i. e.*, a *dubitative* mode; another that he makes a declaration on hearsay, *i. e.*, a *quotative* mode; another form will be used in making a command, giving an *imperative* mode; another in implora-

tions, *i. e.*, an *implorative* mode; another form to denote permission, *i. e.*, a *permissive* mode; another in negation, *i. e.*, a *negative* mode; another form will be used to indicate that the action is simultaneous with some other action, *i. e.*, a *simulative* mode; another to denote desire or wish that something be done, *i. e.*, a *desiderative* mode; another that the action ought to be done, *i. e.*, an *obligative* mode; another that action is repetitive from time to time, *i. e.*, a *frequentative* mode; another that action is caused, *i. e.*, a *causative* mode, etc.

These forms of the verb, which we are compelled to call modes, are of great number. Usually with each of them a particular modal particle or incorporated adverb will be used; but the particular particle which gives the qualified meaning may not always be discovered; and in one language a different word will be introduced where in another the same word will be used with an incorporated particle.

It is stated above that incorporated particles may be used to indicate direction, manner, instrument, and purpose; in fact, any adverbial qualification whatever may be made by an incorporated particle instead of an adverb as a distinct word.

No line of demarkation can be drawn between these adverbial particles and those mentioned above as modal particles. Indeed, it seems best to treat all these forms of the verb arising from incorporated particles as distinct modes. In this sense, then, an Indian language has a multiplicity of modes. It should be further remarked that in many cases these modal or adverbial particles are excessively worn, so that they may appear as additions or changes of simple vowel or consonant sounds. When incorporated particles are thus used, distinct adverbial words, phrases, or clauses may also be employed, and the idea expressed twice.

In an Indian language it is usually found difficult to elaborate a system of tenses in paradigmatic form. Many tenses or time particles are found incorporated in verbs. Some of

these time particles are excessively worn, and may appear rather as inflections than as incorporated particles. Usually rather distinct present, past, and future tenses are discovered; often a remote or ancient past, and less often an immediate future. But great specification of time in relation to the present and in relation to other times is usually found.

It was seen above that adverbial particles cannot be separated from modal particles. In like manner tense particles cannot be separated from adverbial and modal particles.

In an Indian language adverbs are differentiated only to a limited extent. Adverbial qualifications are found in the verb, and thus there are a multiplicity of modes and tenses, and no plane of demarkation can be drawn between mode and tense. From preceding statements it will appear that a verb in an Indian tongue may have incorporated with it a great variety of particles, which can be arranged in three general classes, *i. e.* pronominal, adverbial, and prepositional.

The pronominal particles we have called article pronouns; they serve to point out a variety of characteristics in the subject, object, and indirect object of the verb. They thus subserve purposes which in English are subserved by differentiated adjectives as distinct parts of speech. They might, therefore, with some propriety, have been called adjective particles, but these elements perform another function; they serve the purpose which is usually called "agreement in language;" that is, they make the verb agree with the subject and object, and this indicate the syntactic relation between subject, object, and verb. In this sense they might with propriety have been called relation particles, and doubtless this function was in mind when some of the older grammarians called them transitions.

The adverbial particles perform the functions of voice, mode, and tense, together with many other functions that are performed in languages spoken by more highly civilized people by differentiated adverbs, adverbial phrases, and clauses.

The prepositional particles perform the function of indicating a great variety of subordinate relations, like the prepositions used as distinct parts of speech in English.

By the demonstrative function of some of the pronominal particles, they are closely related to adverbial particles, and adverbial particles are closely related to prepositional particles, so that it will be sometimes difficult to say of a particular particle whether it be pronominal or adverbial, and of another particular particle whether it be adverbial or prepositional.

Thus the three classes of particles are not separated by absolute planes of demarkation.

The use of these particles as parts of the verb; the use of nouns, adjectives, adverbs, and prepositions as intransitive verbs; and the direct use of verbs as nouns, adjectives, and adverbs, make the study of an Indian tongue to a large extent the study of its verbs.

To the extent that voice, mode, and tense are accomplished by the use of agglutinated particles or inflections, to that extent adverbs and verbs are undifferentiated.

To the extent that adverbs are found as incorporated particles in verbs, the two parts of speech are undifferentiated.

To the extent that prepositions are particles incorporated in the verb, prepositions and verbs are undifferentiated.

To the extent that prepositions are affixed to nouns, prepositions and nouns are undifferentiated.

In all these particulars it is seen that the Indian tongues belong to a very low type of organization. Various scholars have called attention to this feature by describing Indian languages as being holophrastic, polysynthetic, or synthetic. The term synthetic is perhaps the best, and may be used as synonymous with undifferentiated.

Indian tongues, therefore, may be said to be highly synthetic in that their parts of speech are imperfectly differentiated.

In these same particulars the English language is highly organized, as the parts of speech are highly differentiated. Yet the difference is one of degree, not of kind.

To the extent in the English language that inflection is used for qualification, as for person, number, and gender of the noun and pronoun, and for mode and tense in the verb, to that extent the parts of speech are undifferentiated. But we have seen that inflection is used for this purpose to a very slight extent.

There is yet in the English language one important differentiation which has been but partially accomplished. Verbs as usually considered are undifferentiated parts of speech; they are nouns and adjectives, one or both, and predicants. The predicant simple is a distinct part of speech. The English language has but one, the verb *to be*, and this is not always a pure predicant, for it sometimes contains within itself an adverbial element when it is conjugated for mode and tense, and a connective element when it is conjugated for agreement. With adjectives and nouns this verb is used as a predicant. In the passive voice also it is thus used, and the participles are nouns or adjectives. In what is sometimes called the progressive form of the active voice nouns and adjectives are differentiated in the participles, and the verb "to be" is used as a predicant. But in what is usually denominated the active voice of the verb, the English language has undifferentiated parts of speech. An examination of the history of the verb "to be" in the English language exhibits the fact that it is coming more and more to be used as the predicant, and what is usually called the common form of the active voice is coming more and more to be limited in its use to special significations.

The real active voice, indicative mode, present tense, first person, singular number, of the verb "to eat," is "am eating." The expression "I eat," signifies "I am accustomed to eat." So, if we consider the common form of the active voice throughout its entire conjugation, we discover that many of its forms are limited to special uses.

Throughout the conjugation of the verb the auxiliaries are predicants, but these auxiliaries, to the extent that they

are modified for mode, tense, number, and person, contain adverbial and connective elements.

In like manner many of the lexical elements of the English language contain more than one part of speech: "To ascend" is to go up; "to descend" is to go down; and "to depart" is to go from.

Thus it is seen that the English language is also synthetic in that its parts of speech are not completely differentiated. The English, then, differs in this respect from an Indian language only in degree.

In most Indian tongues no pure predicant has been differentiated, but in some the verb *to be*, or predicant, has been slightly developed, chiefly to affirm existence in a place.

It will thus be seen that by the criterion of organization Indian tongues are of very low grade.

It need but to be affirmed that by the criterion of sematologic content Indian languages are of a very low grade. Therefore, the frequently-expressed opinion that the languages of barbaric peoples have a more highly organized grammatic structure than the languages of civilized peoples has its complete refutation.

It is worthy of remark that all paradigmatic inflection in a civilized tongue is a relic of its barbaric condition. When the parts of speech are fully differentiated and the process of placement fully specialized, so that the order of words in sentences has its full significance, no useful purpose is subserved by inflection.

Economy in speech is the force by which its development has been accomplished, and it divides itself properly into economy of utterance and economy of thought. Economy of utterance has had to do with the phonic constitution of words; economy of thought has developed the sentence.

All paradigmatic inflection requires unnecessary thought. In the clause "if he was here," "if" fully expresses the subjunctive condition, and it is quite unnecessary to express it a second time by using another form of the verb "to be." And so the people who are using the English language are

deciding, for the subjunctive form is rapidly becoming obsolete with a long list of paradigmatic forms which have disappeared.

Every time the pronoun *he*, *she*, or *it* is used it is necessary to think of the sex of its antecedent, though in its use there is no reason why sex should be expressed say one time in ten thousand. If one pronoun non-expressive of gender were used instead of the three, with three gender adjectives, then in nine thousand nine hundred and ninety-nine cases the speaker would be relieved of the necessity of an unnecessary thought and in the one case an adjective would fully express it. But when these inflections are greatly multiplied, as they are in the Indian languages, alike with the Greek and Latin, the speaker is compelled in the choice of a word to express his idea to think of a multiplicity of things which have no connection with that which he wishes to express.

A Ponca Indian, in saying that a man killed a rabbit, would have to say the man, he, one, animate, standing, in the nominative case, purposely killed, by shooting an arrow, the rabbit, he, the one, animate, sitting, in the objective case; for the form of a verb to kill would have to be selected, and the verb changes its form by inflection and incorporated particles to denote person, number, and gender as animate or inanimate, and gender as standing, sitting, or lying, and case; and the form of the verb would also express whether the killing was done accidentally or purposely, and whether it was by shooting or by some other process, and, if by shooting, whether by bow and arrow, or with a gun; and the form of the verb would in like manner have to express all of these things relating to the object; that is, the person, number, gender, and case of the object; and from the multiplicity of paradigmatic forms of the verb to kill this particular one would have to be selected. Perhaps one time in a million it would be the purpose to express all of these particulars, and in that case the Indian would have the whole expression in one compact word, but in the nine hundred and ninety-nine thousand

nine hundred and ninety-nine cases all of these particulars would have to be thought of in the selection of the form of the verb, when no valuable purpose would be accomplished thereby.

In the development of the English, as well as the French and German, linguistic evolution has not been in vain.

Judged by these criteria, the English stands alone in the highest rank; but as a written language, in the way in which its alphabet is used, the English has but emerged from a barbaric condition.

ABSTRACT OF PAPERS
READ BEFORE THE
ANTHROPOLOGICAL SOCIETY
OF
WASHINGTON, D. C.,
FOR THE
YEAR ENDING JANUARY 18, 1881.

SEVENTEENTH REGULAR MEETING.

FEBRUARY 3, 1880.

**The Mound-Builders : An Inquiry Into Their Assumed
Southern Origin.**

By WILLS DE HASS.

Claims in behalf of the southern origin of the Mound-Builders have been frequently advanced. Among the recent advocates of the theory Mr. Morgan and Professor W. Denton were especially mentioned. The latter gentleman was represented to have maintained that the Mound-Builders were Mexicans who came north to work the Lake Superior copper mines, on the following grounds: 1, Lake Superior copper has been found both in the mounds and in the teocallis. 2, The mounds and teocallis are frequently similar in shape, and obsidian knives occur in both. 3, After Cortez conquered Mexico the Mound-Builders began to disappear.

To these assertions Mr. De Hass replies: 1. The identity of Mound-Builders with any tribe of Mexicans cannot be sustained. 2. The resemblance of the mounds to the teocallis is not sufficient to establish the identity of those who erected them. 3. Sacrificial mounds in the Ohio valley are purely mythical. 4. Worked obsidian has not been found in western tumuli. 5. No records exist concerning the Mound-Builders since the conquest of Mexico. 6. No mounds are found within several hundred miles of the Lake Superior copper region. 7. Copper implements are very rare, even in the mounds.

Mr. Morgan's theory is stated in the form of questions: 1. Did the Mound-Builders come from the south? 2. Were they village Indians? 3. Were their mural works designed to support dwellings? All of these are answered by Mr. Morgan in the affirmative.

Mr. De Hass, reviewing these questions in their order, replied:

1. The vast and complicated systems of earthworks stretching from the lakes to the Gulf become more complicated and formidable as we proceed southward. It is not improbable that the Mound-Builders divided at some point in the Mississippi Valley—one portion going southeast into Florida, and thence across to the West Indies; the other, sweeping over Indian Territory, Texas, New Mexico, Arizona, Chihuahua, and other portions of northern Mexico, finally reached the valley of Anahuac. The difference in the art relics of the two regions were adduced to show that there had not been a northern migration. Indeed, not a single tropical animal or plant appears upon the fictile ware or the sculptures of the Mound-Builders.

The position assumed by Mr. Morgan that the Mound-Builders were our modern Indians was opposed by Mr. De Hass on the ground of their difference in customs of living and sepulture, in monumental and artistic development and in their crania. Again, the sites chosen by the Mound-Builders were the very points selected for some of our most

thriving cities, such as Cincinnati, St. Louis, Chillicothe, Columbus, Portsmouth, Vincennes, Marietta, Mondville, etc., while, by Mr. Morgan's own admission, "this very region unoccupied at the time of European discovery, because unadapted to tribes in the lower status of barbarism."

If the banks of the Ohio works were the sites of communal dwellings, by all analogy, we should find some evidence of the fact in the *débris*. There are no abandoned hearths, charcoal, carbonized bones, broken pottery, in or on these works, while the recent explorations of the pueblos and cliff dwellings reveal immense quantities of these relics there.

Again, we have positive evidence in the mounds, and in cists beneath the works, that many of these tumuli, and even some of the earth-walls were erected for burial purposes.

Mr. De Hass, in conclusion, drew attention to the following facts:

I. Not a single specimen of wrought-stone for building purposes has been discovered within the Mound-Builders' area.

II. The pottery of the mounds is of the rudest character, while that of the Pueblos and of Mexico is elaborately formed and decorated. It is not probable that a people who have once learned the art of pottery would soon forget it.

III. The Mexicans understood the art of hardening copper and of making bronze.

IV. The Mound-Builders dwelt in communities near their mounds and works, as is attested by their camp-sites and cemeteries.

V. Mounds were primarily designed for burial.

VI. All mural mounds can be proved to have been for defense, amusement, or religion.

EIGHTEENTH REGULAR MEETING.

FEBRUARY 17, 1880.

Burial Customs of the North American Indians.

BY H. C. YARROW.

This paper has been published in full, in the Introduction to the study of the Mortuary Customs of the North American Indians, by the same author, issued by the Bureau of Ethnology.

The Development of Deliberative Government among the North American Indians.

BY J. HOWARD GORE.

War compelled the savages to remain in a family union. This family was ruled by the parent from whom it had its origin. A greater danger or a desire to govern other bands caused families to coalesce. In order to secure harmony of action and successful results, there must be no division of governmental power, for acquiescence to authority among warlike people is on account of fear or respect for an individual. The man who ran the fastest, killed the greatest number of enemies, and took the most booty, would be the actual and eventually the accepted leader of the tribe. When the necessity which caused this alliance of families was removed, there would be a tendency to separate, so that the leader in war in order to be a ruler in peace must rely upon superstitious ceremony, from which all later ceremony developed. The sons of this chief, inheriting their father's strength and skill, would be the wealthiest successors to the chieftaincy—the eldest only serving. As the tribe increased in number, the chief called in men of wisdom or skill for advisors. The utility of this step becoming apparent, the power of the chief decreased, while that of the councillors

became greater. Finally, men become members of the council by obtaining a standard accomplishment or requisite age.

The chief, or the councilman from the family which originally furnished the chief, commenced all discussion. The others spoke in order of the importance of the families to which they belonged. Women were sometimes admitted, whose business it was to remember the proceedings and narrate them to their children. All measures were decided by a unanimous majority. If there was a difference of opinion the minority usually yielded, if not, no decision would be reached. A tribe, when very large, or the union of several small tribes of the same stock-language, was called a nation, whose government was the same as the tribe. The highest type of government was the confederacy of nations, as the Iroquois, Ottawa, Creek, and Powhattan.

The regulations of the Iroquois League when America was first settled was as follows: A council of sachems, limited in number, equal in power, a union of six nations, each remaining independent in all matters pertaining to local government. Unanimity in council, sachems voted by tribes, council open to orators of the people for the discussion of public questions—council alone deciding. Women had a veto power in declaration of war.

In 1836 the Choctaw Nation had a council of forty members elected by popular vote; chiefs had an honorary seat; were not allowed to vote, though they possessed a veto power, over which a two-thirds vote passed; chairman and officers were elected, committees appointed, speakers arose and addressed the chair, questions were put in the usual form, vote given by rising, minutes kept in English and read in Choctaw.

The confederacy is superior, and related to the nation as the nation is to the tribe and the tribe to the family, and the whole resembles our advance from the neighborhood to the county, thence to State, and finally to the union of States.

NINETEENTH REGULAR MEETING.

MARCH 2, 1880.

[Annual Address of the President.]

TWENTIETH REGULAR MEETING.

MARCH 16, 1880.

The Four Creations of Mankind—A Tualati Myth.

By A. S. GATSCHET.

In olden times people swarmed in the region of the Columbia and Willamette rivers. No sickness prevailed and everybody grew up to old age. Five men then started out on a hunting expedition, taking with them a dog. They camped out five nights, and on the evening of the fifth day, when the dog came home, a little girl asked: "How much game has been killed by your party?" The dog made no reply. The little girl asked the same question five times, when the dog replied: "Five were killed." After this the world turned upon itself, all human beings became stars, and there was nobody left on earth save the girl, whom the dog took to himself for a wife. She first bore to him a dog and a babe, and becoming pregnant a second time was again delivered of a babe and a dog. From these children there came other children, and the country again swarmed with people. Then one man said to another: "A new people will soon come in large numbers; we had better retire from here, or be changed into some other form, for in a short space of time there will be none of us left on earth." The man who said this was a chief, and he traveled all over the land and told everybody the same thing. When he returned to his home all the people had been transformed into the pebbles which still glitter from the bottoms of the rivers.

Of old there was no water on the earth ; men sucked the moisture from wooden sticks, and snapped their tongues for water. Then a third people settled on the earth and became numerous. Two women stole an infant girl and kept her secretly for years. She grew up to be a maiden and went out to dig kamas. A flint-boy found her on the kamas-fields and brought her back to her mother. The two women who had stolen her became angry thereat and danced to make it rain. It rained for twenty days, and a flood covered all the mountain-tops. Everybody perished except the girl, and the flint-boy who had grown up to be a flint man. He hid her in his armpit, and upon this the waters subsided. Perceiving the two women who had caused the rain to come down in such torrents, he put them to death, and on burning them he collected their ashes and blew them up to the sky, and said: "You shall no longer travel on earth; you shall be clouds, and only when the clouds become heavy, *then* it will rain. That is all will remain of you." This is why no one can make rain now.

Then all human beings were changed into animals that live in the water; some into salmon, some into eels, some into beavers, and other aquatic animals. Thus it came that "this our ancient people" now live in the depths of the sea. They are there as large and small salmon, lobsters, sea otters, land otters, minks, seals, and other monsters of the deep. This is the third generation of mankind.

But from the flint-boy and the girl another people grew up, and their descendants filled the world for the fourth time. In those days there lived in a lodge a poor family, consisting of a woman and her husband, a son and a little daughter. One day a crow came into the lodge and said to the man: "Make a bow and arrows!" When he had finished these the crow said: "Now go out and hunt in the woods; kill the white-tailed deer, the elk, the black bear, the cougar, the wild cat, and the grizzly bear; kill all kinds of animals, eat their flesh, make blankets and dresses for yourselves from their skins which are good to wear, and grow rich."

Thus spoke the crow to the man; to the woman it said: "Take a stick, sharpen the end, and dig kamas root, the wild carrot, and other eatable roots in the ground; get the wild potato out of the swamp; then you will be poor no longer; and give up the daughter to me; I shall take care of her."

Then the mother inquired of the crow: "How can you take care of my child?" The crow answered, "I shall lay her down on my wing." "But she might fall down," said the mother. "She cannot possibly fall," said the crow, "but let us see, let us try." The crow put the child on its wings; high up it went into the sky; down again it flew, wavered and beat its wings, but the child did not fall. Then the mother consented and delivered the child to the crow, which flew off.

The couple did as the crow had told them; their food became abundant; they got rich and remained in their lodge one year. In the meanwhile the crow had picked up a small pebble and threw it into the fire near which the little girl was playing. Suddenly the pebble burst to pieces and struck the girl on her belly. Thus she became pregnant, and two months after was delivered of a son. She was but one year old when she bore the child. In five days the child talked, in ten days it walked around, in fifteen days it started out hunting birds, in twenty days it killed a pheasant, in twenty-five a young deer, in thirty a large deer, in thirty-five a young elk, in forty a large elk. Then the boy said to his grandmother, "I want to drink water." She replied, "There is no water." He said, "Wherefore is there no water?" She answered, "There never has been any water since people were created." The boy said, "It is bad that there is no water, for soon a new people will come, and water will be welcome to them. How did you do when you wanted to drink?" The grandmother said, "From the trees we peeled off the bark and sucked or lapped up the sap or moisture." The boy said, "It is not good to do so; I am going to look out for water. Do you see the sun standing in the sky?"

"Yes," replied she. "Do you see the moon? That is the place where I am going to get the water, and if there is none, I will go to the sun; perhaps they have some water there." "That's right," said the grandmother.

The boy set out and arrived at the house of the moon. The moon asked, "Where do you come from?" The boy said, "I am traveling in search of water." The moon said, "I have no water here but the sun has water. The sun is angry now, but you go there and I will give you good smelling grass to take along with you. The sun has a child, and that child will smell the grass, and then the sun will give you water." The boy said, "Hand me over the grass." And the moon gave him the grass and then the boy started out for the sun's house. There he saw the daughter of the sun. "Oh," she said, "you smell so good!" "Yea," said the boy, "I smell good! Hurry up and give me some water." And grasping a wooden vessel, he went to get water, telling her to come with him. They went to the nearest house and there he beheld water. On the shore of the lake was a canoe with two paddles lying in it. Overwhelmed with joy, the boy exclaimed, "Oh, what a nice canoe!" The sun's daughter said, "Step into it and let us play on the water; turn your face the other way." And the boy stepped into the canoe and dipped the oars in the water. "Now let us go; let us go all around, everywhere," he said to the water.

Thereupon the waters were loosened all around, everywhere the waters started and sprung up. Thus the boy first made the sea, then the larger rivers, then all the creeks, streams and streamlets, and when he had done he exclaimed: "Now, I have made and finished all the waters, and the waters are good! When the new people arrive they will have water enough and will never be in want of it."

This was the life and end of the fourth people on earth.

TWENTY-FIRST REGULAR MEETING.

APRIL 6, 1880.

**The Indian Title.—The Method and Chronology of its
Extinguishment by the United States.**

BY C. C. ROYCE.

The discovery of the American Continent with its supposed marvelous wealth of precious metals and commercial woods, gave fresh impetus to the ambition and cupidity of European monarchs.

Spain, France, Holland, and England, each sought to rival and out do the other in the magnitude and value of her discoveries.

As the primary object of each of these European potentates was the same, and as it was likely to lead to much conflict of jurisdiction, the necessity of some general rule became apparent, whereby their respective claims might be acknowledged and adjudicated without resort to the arbitrament of arms. Out of this necessity grew the rule, which became a part of the recognized law of Nations, and which gave the preference of title to the monarch whose vessels should be the first to discover, rather than to the one who should first enter upon the possession of new lands.

The result of this rule was to give the monarch of the discovering nation the sole right of acquiring the soil from the natives. This right was asserted and fully recognized by all the commercial nations of Europe in their dealings with each other. It carried with it a modification of the Indian title to a simple right of possession, with the ultimate fee resting in the discovering sovereign.

No one of these nations was more zealous in her maintenance of these doctrines than England. Her claims to this continent were based upon the discoveries of Cabot; those of France from Verrazani, and Spain pleaded the discoveries of Ponce de Leon as her title-deed.

As the successor of England to her original North American possessions, the policy of the United States since the adoption of the Federal Constitution has followed the precedent established by the mother country.

In the treaty of peace in 1783, between Great Britain and the United States, the former relinquished all claim to all the country south and west of the great northern rivers and lakes as far as the Mississippi. During the period between the conclusion of this treaty and the year 1789, it was held by Congress that the relinquishment of territory thus made by Great Britain, with no saving clause guaranteeing the Indian right of occupancy, carried with it an unqualified fee-simple title, unembarrassed by any intermediate estate or tenancy.

The Indians were even required to acknowledge the absolute title of the United States in the treaties of 1784 and 1786, with the Six Nations and Shawnees respectively.

The breadth and boldness of the territorial claims thus asserted by the United States were not long in producing their natural effect. Joseph Brant succeeded in reviving his favorite project of an alliance between the Six Nations and northwestern tribes. A grand council was assembled at Huron Village, opposite Detroit, in 1786, which resulted in the formulation of an address to Congress by the Indians, expressing a desire for peace, but firmly insisting that all treaties with the United States must be with the general voice of the whole confederacy, and that the Ohio River must be the boundary between Indian Territory and the United States. This address purported to represent the Five Nations, Hurons, Ottawas, Twichtwees, Shawnees, Chipewas, Cherokees, Delawares, Pottawatomies, and the Wabash Confederates.

Considering the weakness of the Government under the old articles of confederation, and the exhausted condition immediately following the Revolution, such a remonstrance caused a profound sensation, and Congress hastened to make

an appropriation for the extinguishment of Indian claims to lands already ostensibly ceded to the United States.

Two treaties negotiated at Fort Harmar, opposite Marietta, Ohio, in 1789, were the result. One with the Six Nations, and the other with tribes north and west of the Ohio River, wherein the Indian title of occupancy was acknowledged, subject to extinguishment only by purchase, or as the result of a justifiable war.

Though more than once questioned, this principle has invariably been sustained by the courts of final resort. The decisions of the Supreme Court of the United States bear consistent testimony to its legal soundness in three leading cases—in 1823, 1831, and 1832. In the second of these decisions, Chief Justice Marshall, in delivering the opinion, maintained that the Cherokees were a State; that the treaties with them recognized them as a people capable of maintaining the relations of peace and war; that the condition of the Indians, in their relations to the United States, was unlike that of any other people; that, in general, nations not owing a common allegiance are foreign to each other; but that the relation of the Indians to the United States was marked by peculiar and cardinal distinctions which existed nowhere else; that the Indians had an unquestionable right to the lands they occupied, until it should be extinguished by voluntary cession to the United States; that they could not be denominated foreign nations, but might more accurately be called domestic dependent nations.

The Government of the United States being thus thoroughly committed to the principle of Indian right of occupancy of their uncaded lands, it becomes a subject of interest to the student of history as well as an addition of practical value to the official records of the Government, to have a carefully compiled work, showing the boundaries of the several tracts of country which have been thus acquired from time to time (within the present limits of the United States) by cession or relinquishment from the various Indian tribes.

Such a work would form the basis of any complete history of our aboriginal tribes in their relations to and effects upon the growth and diffusion of our population. It has for some time past been in course of preparation, and it is hoped will within a reasonable period reach completion. To give more intelligent idea of the scope of the work, a rough preliminary map was presented, upon which was outlined in colors and numerically designated each cession of the territory, made by the Indians under treaty stipulations, since the establishment of the Federal Government, so far as the scale of the map would permit. Many of the cessions of but a few miles square could only be shown upon a map of much larger scale.

This work, in course of preparation by Mr. Royce, will include an atlas of the United States exhibiting the several cessions of land by the Indians to the United States, and the text will include a chronologic list of treaties with the various Indian tribes exhibiting the date, place where, and person by whom negotiated, a history of the causes leading to the several treaties as exhibited by contemporary correspondence and other trustworthy data. An alphabetic list of all rivers, lakes, mountains, villages and other points mentioned in such treaties, together with the situation thereof, and the present names of such of these objects or places, the nomenclature of which has been changed since the date of the treaties in which they are mentioned will be given. Also an alphabetical list of rivers, lakes, and mountains in the United States, showing not only their present names, but those by which they have been known since the discovery of America, giving the date and authority therefor. The several features of this plan were elaborately illustrated by Mr. Royce.

TWENTY-SECOND REGULAR MEETING.

APRIL 20, 1880.

Pre-Social Man.

BY L. F. WARD.

The speaker said it might safely be given as the opinion of those naturalists who accept the animal origin of the human race that at some time and in some part of the world some one group, possibly a very limited one, of the ape family acquired certain of the characters which now distinguish the human from the simian anatomy. These characters he summed up as follows: Increased capacity of the cranium and increased size of the encephalon; greater complication in the mechanism of the larynx; the erect posture of the body; the plantigrade character of the feet; non-possibility of the great toe; diminished length of the arms in proportion to the trunk; greater or less absence of hair from most of the body and limbs, and double curvature of the spine. Among these points of difference there was a certain inter-dependence, so that on the principle of adaptation they would all flow from some one or two of the chief ones, and he thought that the first of these characters to be acquired by the simian ancestors of our race must have been the increased size of brain, which might have resulted from the necessity certain apes were under, of depending on superior cunning for protection against animals of greater strength and ferocity than themselves; and this character once acquired, together with the modifications resulting from the substitution of terrestrial for aboreal habits, the rest would follow.

It was pointed out, too, that the immediate progenitor of man among the anthropoids might have been considerably nearer to the human form than any of the known anthropoids now are, as would be the case if there were a creature combining the full chest of the gibbon, the skull of the

Chimpanzee, the short arms and man-like hands and feet of the gorilla, the size of brain of the orang-outang, and the features of *Semnopithicus*, *Cercopithicus*, or *Mormon*. That such a form once existed was as reasonable as that the orang-outang should exist. Increase of brain an accompanying increases of intelligence was due to two causes: 1. Efforts to evade enemies through the exercise of sagacity or cunning; 2. Efforts to obtain food by skill and strategy. The first of these was rendered necessary to a greater degree than in the case of other animals in consequence of a notable absence of the means of defence with which most animals are endowed. The second was also due in great part to the lack of offensive weapons and other specialized means of pursuing any one peculiar mode of life. To understand this better, however, another important fact must be considered. Nearly or quite all the animals of the family from which man has descended are strictly arboreal. They are usually light and supple creatures, adapted to life in trees, subsisting chiefly upon the nuts and fruits which they yield. But some of the anthropoids, the gorilla, for example, have attained so large a size and so great a weight that arboreal existence has become difficult and they have descended to the ground. The ancestor of man must have belonged to this class and early become at least a partially terrestrial animal. The effect of this was both to increase the number and character of his enemies and to diminish his supply of natural food. Both these circumstances combined in increasing the necessity for mental exertion which in turn was the immediate cause of his rapid brain development.

Two causes likewise, operated to produce the erect posture, namely: 1st, life on the ground, and, 2d, increased brain mass.

The conformation of the limbs of the ape family is such that life on the ground would naturally cause the fore limbs to be used more and more exclusively as hands, and the hind ones as the only means of locomotion. The enlarged brain accompanied by a still greater increase in the weight of the

skull and other bones of the head would render the horizontal support of the head extremely difficult. The strict laws of mechanical equilibrium, therefore, operating cumulatively through the joint action of both these causes would tend to elevate the forepart of the body until the spine should become vertical, the head be borne directly over this bony axis, the fore limbs completely exempted from duty as organs of locomotion. and the hind limbs devoted exclusively to that purpose.

Respecting the important attribute of speech it was maintained that it is the result of mental far more than physical development. The larynx of many animals, and particularly of the ape family, is known to be highly developed. The true reasons why these animals do not possess articulate speech is because they do not possess sufficient intelligence to invent and employ arbitrary sound-symbols. That they cannot be expected to perform so high an intellectual feat was exemplified by the fact that microcephalous idiots having a brain capacity of less than sixty cubic inches are incapable of being taught to speak, although they possess a well developed larynx and behave in all respects like tamed animals, while the orang, whose brain is larger than that of any other ape, has an encephalon of only thirty-five cubic inches.

Thus, without any violent assumptions, it was shown that all the differences which separate the highest animals from the lowest human races can be accounted for by the natural laws of adaptation as now understood by naturalists.

The three questions of the unity, the local origin, and the antiquity of the human race were then briefly considered. The first may now be regarded as temporarily, if not permanently, settled on the monophyletic basis. The second cannot be expected to be settled, or even placed, in a way of enlightened discussion, until the tropical regions of Asia and Africa shall have been thoroughly explored by paleontologists. As to the third enough is already known to enable us to class man along with many other of the higher mam-

mals now found fossil, as a true product of geologic time. But the fact was strongly insisted upon that the ordinary method of discussing all these questions was vicious, in failing to recognize the underlying question as to what constitutes a being—a man. As no true line of demarkation between apehood and manhood exists there is no fixed point, either genealogical, chorological, or chronological, from which to set out.

TWENTY-THIRD REGULAR MEETING.

MAY 4, 1880.

Who were the Massawomekes?

BY A. L. GUSS.

The paper collected and analyzed all statements of Capt. John Smith concerning this tribe, first met by him in 1608 at the head of Chesapeake Bay. From these it appeared that all the Indians on the Chesapeake and its affluents were in dread of a people named Massawomekes, who were superior to them in numbers and warlike power. The large body of historians have been of opinion that these people were Iroquois proper, commonly called the Five Nations, from the present State of New York. This was denied, and it was contended with much elaboration of argument, deduced from ancient maps and original authorities, that they were a body of the Iroquoian linguistic stock, neither belonging to the Five Nations nor to the Tuscaroras of the South, which latter became, in 1715, the sixth nation of the Confederacy. This theory would proceed to the conclusion that the Tuscaroras were not isolated from the remainder of the linguistic family, but that the latter extended continuously from Canada to North Carolina, occupying all Pennsylvania west of the streams flowing into the Delaware, the upper and western portions of Maryland, and all of Virginia except

the coast belt. An interesting part of the argument was that the Iroquois proper had not, prior to their being armed with guns in 1640, subdued other tribes, and that only after receiving those arms from the Dutch and English they desolated the country southward as far as the Tuscaroras, when their attention was diverted to the Illinois and to wars with the French in Canada. This southern invasion of the Five Nations depopulated the belt of country before mentioned, that was before, and at the time of Smith, occupied by the Massawomekes, which the paper further identified with the Eries.

TWENTY-FOURTH REGULAR MEETING.

MAY 18, 1880.

Dumbarton Aboriginal Soapstone Quarry.

BY E. R. REYNOLDS.

No Paper Furnished.

The Testimony of the Romance Languages concerning the Forms of the Imperfect and Pluperfect Subjunctive in the Roman Folk-Speech.

BY E. A. FAY.

Assuming, as the present state of philological science justifies us in doing, that the so-called Romance languages are simply the natural development of the old Roman folk-speech—which was unwritten, and concerning which we know scarcely anything—the purpose of the paper is to inquire what these languages have to tell us concerning one of its features, viz., its forms of the Imperfect and Pluperfect Subjunctive as compared with the forms of those tenses in the classical or literary language.

As the Romance languages afford no trace whatever of the

classical form of the Latin Imperfect Subjunctive, it is reasonable to suppose that it did not exist in the folk-speech. The explanation of its absence from the modern language on the ground of its resemblance to the Pluperfect and Future Perfect Indicative and Perfect Subjunctive is shown to be unsatisfactory by the persistence of other forms of the verb, more closely resembling one another, and by the fact that in many verbs the similarity in these tenses did not exist.

The classical form of the Pluperfect Subjunctive is employed in all the Romance languages except Wallachian with the meaning of the Imperfect Subjunctive, and the exception in the case of Wallachian can be accounted for by the peculiar corrupting influences with the Roman speech encountered in the Northeast, and the absence of any texts of an earlier date than the end of the fifteenth century. We can therefore conclude with certainty that the literary form of the Pluperfect Subjunctive was used in the popular speech in the sense of the Imperfect Subjunctive. This usage is also found in the earliest Low Latin texts, side by side with the classical form of the Imperfect tense.

In all the Romance languages except Wallachian the Pluperfect Subjunctive is expressed by the Perfect Participle Passive combined with the Pluperfect Subjunctive of *habere* or *esse*. This form, therefore, must have existed, at least in the germ, in the ancient folk-speech. Corroborative evidence that such was the case is furnished by the examples of a similar combination with tenses of *habere* in the classical Latin. The compound form of the Pluperfect Subjunctive expresses the idea of antecedence in a very emphatic and exaggerated manner, and was probably used when it was desired to lay special stress upon this idea.

When it was not desired to give emphasis to the Pluperfect idea the simple tense was probably employed as in the literary language. Numerous examples of this kind are found in the earlier monuments of the Romance languages.

The testimony of the Romance languages concerning the

forms of the Imperfect and Pluperfect Subjunctive in the Roman folk-speech may be summed up as follows:

1. The classical form of the Imperfect Subjunctive probably did not exist among the common people.

2. The classical form of the Pluperfect Subjunctive was used to express the Imperfect and probably also the Pluperfect idea.

3. A compound of the Pluperfect Subjunctive in *habere* and *esse* with the Past Participle Passive was sometimes employed for the Pluperfect tense, probably when the speaker wished to lay special emphasis upon the fact of antecedence.

TWENTY-FIFTH REGULAR MEETING.

JUNE 1, 1880.

Is Thought Possible Without Language?—Case of a Deaf Mute.

By SAMUEL PORTER.

The paper opens with a statement of the theory of Mr. Darwin, Professor Huxley, and Max Müller, in which the rational faculty of man is regarded as the result of the possession of language.

As a contribution to the solution of the question, Professor Porter gave a detailed narrative of Mr. Melville Ballard, now a teacher in the Columbia Institute for Deaf Mutes, at Washington, who has been totally deaf since he was eighteen months old. The speaker stated that those who lose their hearing at such an early age have no advantage over those deaf from their birth.

Mr. Ballard's account of his experience proceeds as follows:

His father and mother, at an early age, endeavored to give him some idea of the Supreme being and of a future life. He pondered the matter over and over in fruitless effort to

penetrate the origin of things. He imagined that men and animals sprung from decayed trees. Seeing the map of the world in hemispheres, he imagined it to be two great disks near each other. The sun and moon were brilliant plates endowed with mysterious power. Once being alarmed by thunder, he imagined a great man in the sky.

At eleven years of age he was delighted with the revelation to his mind of a great Creator of the world. Since then his old perplexities have frequently returned when he has taken up the inquiry as to the beginning of existence on the part of the Creator himself.

Professor Porter, resuming his discussion, remarked that Mr. Ballard's inquiries as to the origin of things were unaided by signs of any sort. It was argued that they belong to the higher order of conceptual thought. As embracing in thought much more than can be individually represented, they involve what may be called the *compendiary mode of thought*. By the capacity of man to arrive at general truths, he is separated by a wide chasm from the brute.

Professor Porter sought to explain conceptual knowledge in such a manner as to free it from some of its traditional difficulties. A concept was defined as the notion of a group of things recognized as related by certain common features, the things being apprehended as indefinite in number and in respect to individual variations. In handling a general conception, we must have something on which to hang the indeterminate part. A word may serve this end. But with the word goes a mental image which is also capable of serving without a word.

The notion of a word is itself a general notion. This admitted, the absurdity of the doctrine that general notions cannot exist without words is evident. For the *figuration* of the conception, words present certain preëminently practical advantages, but this does not invalidate the argument.

Professor Porter objected to Professor Huxley's reference to Galton's composite portraits as illustrating the generation

of ideas, because it leaves out the distinctive element of a general conception.

The characteristics of the mind exhibited by animals was then discussed, and the conclusion reached that from such the human intellect could not be developed.

Dr. Porter, in conclusion, adverted to Huxley's *Life of Hume*, and objected to such terms as "potential beliefs of memory" and "potential beliefs of expectation" as being a method of hiding the author's confusion of thought.

TWENTY-SIXTH REGULAR MEETING.

JUNE 15, 1880.

Wyandot Government—A Short Study of Tribal Society.

BY J. W. POWELL.

In the social organization of the Wyandots four groups are recognized, the family, the gens, the phratry, and the tribe.

THE FAMILY.

The family, as the term is here used, is nearly synonymous with the household. It is composed of the persons who occupy one lodge, or in their permanent wigwams, one section of a communal dwelling. These permanent dwellings are constructed in an oblong form, of poles interwoven with bark. The fire is placed in line along the centre, and is usually built for two families, one occupying the place on each side of the fire.

The head of the family is a woman.

THE GENS.

The gens is an organized body of consanguineal kindred in the female line. "The woman carries the gens," is the

formulated statement by which a Wyandot expresses the idea that descent is in the female line. Each gens has the name of some animal, the ancestor of such animal being its tutelary god. Up to the time that the tribe left Ohio, eleven gentes were recognized, as follows:

Deer, Bear, Highland Turtle (striped), Highland Turtle (black), Mud Turtle, Smooth Large Turtle, Hawk, Beaver, Wolf, Sea Snake, and Porcupine.

In speaking of an individual he is said to be a Wolf, a Bear, or a Deer, as the case may be, meaning thereby that he belongs to that gens; but in speaking of the body of people comprising a gens they are said to be relatives of the Wolf, the Bear, or the Deer, as the case may be.

There is a body of names belonging to each gens, so that each person's name indicates the gens to which he belongs. These names are derived from the characteristics, habits, attitudes, or mythologic stories connected with the tutelary god.

The following schedule presents the name of a man and a woman in each gens, as illustrating this statement:

	Wun-dát.	English.
Man of Deer gens	De-wa-ti-re	Lean Deer.
Woman " "	A-ya-jin-ta	Spotted Fawn.
Man of Bear "	A-tu-e-tes	Long Claws.
Woman of Bear "	Tsá-ma ⁿ -da-ka-é	Grunting for her Young.
Man of Striped Turtle gens	Ta-há-so ⁿ -ta-ra-ta-se	Going Around the Lake.
Woman of Striped Turtle gens	Tso-wé-yuñ-kyn	Gone from the Water.
Man of Mud Turtle gens	Sha-yan-tsu-wat'	Hard Skull.
Woman of Mud Turtle gens	Ya ⁿ -däsh-shu-räs	Finding Sand Beach, &c.
Man of Smooth Large Turtle gens	Hu ⁿ '-du-cu-tá	Throwing Sand.

	Wun-dát.	English.
Woman of Smooth Large Turtle gens.	Tsu-ca-e ⁿ	Slow Walker.
Man of Wolf gens	Ha-ró-u ⁿ -yû	One who goes about in the Dark; a Prowler.
Woman " "	Ya ⁿ -di-no	Always Hungry.
Man of Snake gens	Hu-ta-hú-sa	Sitting in curled position.
Woman " "	Di-je-rons	One who Ripples the Water, &c.
Man of Porcupine gens	Ha ⁿ -dú-tu ⁿ	The one who puts up Quills.
Woman of Porcupine gens	Ke-ya-runs-kwa	Good-Sighted.

THE PHIRATRY.

There are four phratrics in the tribe, the three gentes, Bear, Deer, and Striped Turtle constituting the first; the Highland Turtle, Black Turtle, and Smooth Large Turtle the second; the Hawk, Beaver, and Wolf the third; and the Sea Snake and Porcupine the fourth.

This unit in their organization has a mythologic basis, and is chiefly used for religious purposes, in the preparation of medicines, and in festivals and games.

The eleven gentes as four phratrics constitute the tribe.

Each gens is a body of consanguineal kindred in the female line, and each gens is allied to other gentes by consanguineal kinship through the male line, and by affinity through marriage.

To be a member of the tribe it is necessary to be a member of a gens; to be a member of a gens it is necessary to belong to some family; and to belong to a family a person must have been born in the family so that the kinship is recognized; or he must be adopted into a family and become a son, brother, or some definite relative; and this artificial relationship gives him the same standing as actual relation-

ship in the family, in the gens, in the phratry and in the tribe.

Thus a tribe is a body of kindred.

Of the four groups thus described, the gens, the phratry, and the tribe constitute the series of organic units; the family, or household as here described, is not a unit of the gens or phratry, as two gentes are represented in each—the father must belong to one gens, and the mother and her children to another.

GOVERNMENT.

Society is maintained by the establishment of government, for rights must be recognized and duties performed.

In this tribe there is found a complete differentiation of the military from the civil government.

CIVIL GOVERNMENT.

The civil government inheres in a system of councils and chiefs.

In each gens there is a council, composed of four women, called Yu-wai-yu-wá-na. These four women councillors select a chief of the gens from its male members—that is, from their brothers and sons. This gentile chief is the head of the gentile council.

The council of the tribe is composed of the aggregated gentile councils. The tribal council, therefore, is composed one-fifth of men and four-fifths of women.

The sachem of the tribe or tribal chief is chosen by the chiefs of the gentes.

There is sometimes a grand council of the gens, composed of the councillors of the gens proper and all the heads of households and leading men—brothers and sons.

There is also sometimes a grand council of the tribe, composed of the council of the tribe proper and the heads of households of the tribe and all the leading men of the tribe.

These grand councils are convened for special purposes.

METHODS OF CHOOSING AND INSTALLING COUNCILLORS AND CHIEFS.

The four women councillors of the gens are chosen by the heads of households—themselves being women. There is no formal election, but frequent discussion is had over the matter from time to time, in which a sentiment grows up within the gens and throughout the tribe that, in the event of the death of any councillor, a certain person will take her place.

In this manner there is usually one, two, or more potential councillors in each gens who are expected to attend all the meetings of the council, though they take no part in the deliberations and have no vote.

When a woman is installed as councillor a feast is prepared by the gens to which she belongs, and to this feast all the members of the tribe are invited. The woman is painted and dressed in her best attire and the sachem of the tribe places upon her head the gentile chaplet of feathers, and announces in a formal manner to the assembled guests that the woman has been chosen a councillor. The ceremony is followed by feasting and dancing, often continued late into the night.

The gentile chief is chosen by the council woman after consultation with the other women and men of the gens. Often the gentile chief is a potential chief through a period of probation. During this time he attends the meetings of the council, but takes no part in the deliberations, and has no vote.

At his installation, the council women invest him with an elaborately ornamented tunic, place upon his head a chaplet of feathers, and paint the gentile totem on his face. The sachem of the tribe then announces to the people that the man has been made chief of the gens, and admitted to the council. This is also followed by a festival.

The sachem of the tribe is selected by the men belonging to the council of the tribe. Formerly the sachemship in-

hered in the Bear gens, but at present he is chosen from the Deer gens, from the fact, as the Wyandots say, that death has carried away all the wise men of the Bear gens.

The chief of the Wolf gens is the herald and the sheriff of the tribe. He superintends the erection of the council-house and has the care of it. He calls the council together in a formal manner when directed by the sachem. He announces to the tribe all the decisions of the council, and executes the directions of the council and of the sachem.

Gentile councils are held frequently from day to day and from week to week, and are called by the chief whenever deemed necessary. When matters before the council are considered of great importance, a grand council of the gens may be called.

The tribal council is held regularly on the night of the full moon of each lunation and at such other times as the sachem may determine; but extra councils are usually called by the sachem at the request of a number of councillors.

Meetings of the Gentile councils are very informal, but the meetings of the tribal councils are conducted with due ceremony. When all the persons are assembled, the chief of the Wolf gens calls them to order, fills and lights a pipe, sends one puff of smoke to the heavens and another to the earth. The pipe is then handed to the sachem, who fills his mouth with smoke, and, turning from left to right with the sun, slowly puffs it out over the heads of the councillors, who are sitting in a circle. He then hands the pipe to the man on his left, and it is smoked in turn by each person until it has been passed around the circle. The sachem then explains the object for which the council is called. Each person in the way and manner he chooses tells what he thinks should be done in the case. If a majority of the council is agreed as to action, the sachem does not speak, but may simply announce the decision. But in some cases there may be protracted debate, which is carried on with great deliberation. In case of a tie, the sachem is expected to speak.

It is considered dishonorable for any man to reverse his decision after having spoken.

Such are the organic elements of the Wyandot Government.

FUNCTIONS OF CIVIL GOVERNMENT.

It is the function of government to preserve rights and enforce the performance of duties. Rights and duties are co-relative. Rights imply duties, and duties imply rights. The right inhering in the party of the first part imposes a duty on the party of the second part. The right and its co-relative duty are inseparable parts of a relation that must be maintained by government; and the relations which governments are established to maintain may be treated under the general head of rights.

In Wyandot Government these rights may be classed as follows:

First—Rights of marriage.

Second—Rights to names.

Third—Rights to personal adornments.

Fourth—Rights of order in encampments and migrations.

Fifth—Rights of property.

Sixth—Rights of person.

Seventh—Rights of community.

Eighth—Rights of religion.

To maintain rights, rules of conduct are established, not by formal enactment, but by regulated usage. Such custom-made laws may be called regulations.

MARRIAGE REGULATION.

Marriage between members of the same gens is forbidden, but consanguineal marriages between persons of different gentes are permitted. For example, a man may not marry his mother's sister's daughter, as she belongs to the same gens with himself; but he can marry his father's sister's daughter, because she belongs to a different gens.

Husbands retain all their rights and privileges in their

own gentes, though they live with the gentes of their wives. Children, irrespective of sex, belong to the gens of the mother. Men and women must marry within the tribe. A woman taken to wife from without the tribe must first be adopted into some family of a gens other than that to which the man belongs. That a woman may take for a husband a man without the tribe he must also be adopted into the family of some gens other than that of the woman. What has been called by some ethnologists endogamy and exogamy, are correlative parts of one regulation, and the Wyandots, like all other tribes of which we have any knowledge in North America, are both endogamous and exogamous.

Polygamy is permitted, but the wives must belong to different gentes. The first wife remains the head of the household. Polyandry is prohibited. A man seeking a wife consults her mother, sometimes direct, and sometimes through his own mother. The mother of the girl advises with the women councillors to obtain their consent, and the young people usually submit quietly to their decision. Sometimes the woman councillors consult with the men.

When a girl is betrothed, the man makes such presents to the mother as he can. It is customary to consummate the marriage before the end of the moon in which the betrothal is made. Bridegroom and bride make promises of faithfulness to the parents and women councillors of both parties. It is customary to give a marriage feast in which the gentes of both parties take part. For a short time, at least, bride and groom live with the bride's mother, or rather in the original household of the bride.

The time when they will set up housekeeping for themselves is usually arranged before marriage.

In the event of the death of the mother, the children belong to her sister or to her nearest female kin, the matter being settled by the council women of the gens. As the children belong to the mother, on the death of the father the mother and children are cared for by her nearest male relative until subsequent marriage.

NAME REGULATIONS.

It has been previously explained that there is a body of names, the exclusive property of each gens. Once a year at the green-corn festival, the council women of the gens select the names for the children born during the previous year, and the chief of the gens proclaims these names at the festival. No person may change his name, but every person, man or woman, by honorable or dishonorable conduct, or by remarkable circumstance, may win a second name commemorative of deed or circumstance, which is a kind of title.

REGULATIONS OF PERSONAL ADORNMENT.

Each clan has a distinctive method of painting the face, a distinctive chaplet to be worn by the gentile chief and council women when they are inaugurated, and subsequently at festival occasions, and distinctive ornaments for all its members, to be used at festivals and religious ceremonies.

REGULATIONS OF ORDER IN ENCAMPMENT AND MIGRATIONS.

The camp of the tribe is in an open circle or horse-shoe, and the gentes camp in following order, beginning on the left and going around to the right:

Deer, Bear, Highland Turtle (striped), Highland Turtle (black), Mud Turtle, Smooth Large Turtle, Hawk, Beaver, Wolf, Sea Snake, Porcupine.

The order in which the households camp in the gentile group is regulated by the gentile councillors and adjusted from time to time in such a manner that the oldest family is placed on the left, and the youngest on the right. In migrations and expeditions the order of travel follows the analogy of encampment.

PROPERTY RIGHTS.

Within the area claimed by the tribe each gens occupies a smaller tract for the purpose of cultivation. The right of

the gens to cultivate a particular tract is a matter settled in the council of the tribe, and the gens may abandon one tract for another only with the consent of the tribe. The women councillors partition the gentile land among the householders, and the household tracts are distinctly marked by them. The ground is re-partitioned once in two years. The heads of households are responsible for the cultivation of the tract, and should this duty be neglected the council of the gens calls the responsible parties to account.

Cultivation is communal; that is, all of the able-bodied women of the gens take part in the cultivation of each household tract in the following manner:

The head of the household sends her brother or son into the forest or to the stream to bring in game or fish for a feast; then the able-bodied women of the gens are invited to assist in the cultivation of the land, and when this work is done a feast is given.

The wigwam or lodge and all articles of the household belong to the woman—the held of the household—and at her death are inherited by her eldest daughter, or nearest of female kin. The matter is settled by the council women. If the husband die his property is inherited by his brother or his sister's son, except such portion as may be buried with him. His property consists of his clothing, hunting and fishing implements and such articles as are used personally by himself.

Usually a small canoe is the individual property of the man. Large canoes are made by the male members of the gentes, and are the property of the gentes.

RIGHTS OF PERSON.

Each individual has a right to freedom of person and security from personal and bodily injury, unless adjudged guilty of crime by proper authority.

COMMUNITY RIGHTS.

Each gens has the right to the services of all its women

in the cultivation of the soil. Each gens has the right to the service of all its male members in avenging wrongs, and the tribe has the right to the service of all its male members in time of war.

RIGHTS OF RELIGION.

Each phratry has the right to certain religious ceremonies and the preparation of certain medicines.

Each gens has the exclusive right to worship its tutelar god, and each individual has the exclusive right to the possession and use of a particular amulet.

CRIMES.

The violations of rights are crimes. Some of the crimes recognized by the Wyandots are as follows :

- | | |
|--------------|----------------|
| 1. Adultery. | 4. Murder. |
| 2. Theft. | 5. Treason. |
| 3. Maiming. | 6. Witchcraft. |

A maiden guilty of fornication may be punished by her mother or female guardian, but if the crime is flagrant and repeated, so as to become a matter of general gossip, and the mother fails to correct it, the matter may be taken up by the council women of the gens.

A woman guilty of adultery, for the first offense is punished by having her hair cropped ; for repeated offenses her left ear is cut off.

THEFT.

The punishment for theft is two-fold restitution. When the prosecutor and prosecuted belong to the same gens, the trial is before the council of the gens, and from it there is no appeal. If the parties involved are of different gentes, the prosecutor, through the head of his household, lays the matter before the counsel of his own gens ; by it the matter is laid before the gentile council of the accused in a formal manner. Thereupon it becomes the duty of the council of the accused to investigate the facts for themselves, and to

settle the matter with the council of the plaintiff. Failure thus to do is followed by retaliation in the seizing of any property of the gens which may be found.

MAIMING.

Maiming is compounded, and the method of procedure in prosecution is essentially the same as for theft.

MURDER.

In the case of murder, if both parties are members of the same gens, the matter is tried by the gentile council on complaint of the head of the household, but there may be an appeal to the council of the tribe. When the parties belong to different gentes, complaint is formally made by the injured party, through the chief of his gens, in the following manner:

A wooden tablet is prepared, upon which is inscribed the totem or heraldic emblem of the injured man's gens, and a picture writing setting forth the offence follows.

The gentile chief appears before the chief of the council of the offender, and formally states the offence, explaining the picture-writing, which is then delivered.

A council of the offender's gens is thereupon called and a trial is held. It is the duty of this council to examine the evidence for themselves and to come to a conclusion without further presentation of the matter on the part of the person aggrieved. Having decided the matter among themselves, they appear before the chief of the council of the aggrieved party to offer compensation.

If the gens of the offender fail to settle the matter with the gens of the aggrieved party, it is the duty of his nearest relative to avenge the wrong. Either party may appeal to the council of the tribe. The appeal must be made in due form, by the presentation of a tablet of accusation.

Inquiry into the effect of a failure to observe prescribed formalities developed an interesting fact. In procedure

against crime, failure in formality is not considered a violation of the rights of the accused, but proof of his innocence. It is considered supernatural evidence that the charges are false. In trials for all offences forms of procedure are, therefore, likely to be earnestly questioned.

TREASON.

Treason consists in revealing the secrets of the medicine preparations or giving other information or assistance to enemies of the tribe, and is punished by death. The trial is before the council of the tribe.

WITCHCRAFT.

Witchcraft is punished by death, stabbing, tomahawking, or burning. Charges of witchcraft are investigated by the grand council of the tribe. When the accused is adjudged guilty, he may appeal to supernatural judgment. The test is by fire. A circular fire is built on the ground through which the accused must run from east and west, and from north to south. If no injury is received, he is adjudged innocent; if he falls into the fire, he is adjudged guilty. Should a person accused or having the general reputation of practising witchcraft become deaf, blind, or have sore eyes, earache, headaches, or other diseases considered loathsome, he is supposed to have failed in practising his arts upon others and to have fallen a victim to them himself. Such cases are most likely to be punished.

OUTLAWRY.

The institution of outlawry exists among the Wyandots in a peculiar form. An outlaw is one who by his crimes has placed himself without the protection of his clan. A man can be declared an outlaw by his own clan, who thus publish to the tribe that they will not defend him in case he is injured by another. But usually outlawry is declared only after trial before the tribal council.

The method of procedure is analogous to that in case of murder. When the person has been adjudged guilty, and sentence of outlawry declared, it is the duty of the chief of the Wolf clan to make known the decision of the council. This he does by appearing before each clan in the order of its encampment, and declaring in terms the crime of the outlaw and the sentence of outlawry, which may be either of two grades.

In the lowest grade it is declared that, if the man shall thereafter continue in the commission of similar crimes, it will be lawful for any person to kill him; and if killed, rightfully or wrongfully, his clan will not avenge his death.

Outlawry of the highest degree makes it the duty of any member of the tribe who may meet with the offender to kill him.

MILITARY GOVERNMENT.

The management of military affairs inheres in the military council and chief. The military council is composed of all the able-bodied men of the tribe: the military chief is chosen by the council from the Porcupine gens. Each gentile chief is responsible for the military training of the youth under his authority. There is usually one or more potential military chiefs who are the close companions and assistants of the chief in time of war, and in case of the death of the chief take his place in the order of seniority.

Prisoners of war are adopted into the tribe or killed. To be adopted into the tribe it is necessary that the prisoner should be adopted into some family. The warrior taking the prisoner has the first right to adopt him, and his male or female relatives have the right in the order of their kinship. If no one claims the prisoner for this purpose he is caused to run the gauntlet, as a test of his courage.

If at his trial he behaves manfully, claimants are not wanting, but if he behaves disgracefully he is put to death.

FELLOWHOOD.

There is an interesting institution found among the Wyandots, as among some other of our North American tribes, namely, that of fellowhood. Two young men agree to be perpetual friends to each other, or more than brothers. Each reveals to the other the secrets of his life, and counsels with him on matters of importance, and defends him from wrong and violence, and at his death is chief mourner.

The government of the Wyandots, with the social organization upon which it is based, affords a typical example of tribal Government throughout North America. Within that area there are several hundred distinct governments. In so great a number there is great variety, and in this variety we find different degrees of organization, the degrees of organization being determined by the differentiation of the functions of the government and the correlative specialization of organic elements.

Much has yet to be done in the study of these governments before safe generalizations may be made. But enough is known to warrant the following statement:

Tribal government in North America is based on kinship in that the fundamental units of social organization are bodies of consanguineal kindred either in the male or female line: these units being what has been well denominated "gentes."

These "gentes" are organized into tribes by ties of relationship and affinity, and this organization is of such a character that the man's position in the tribe is fixed by his kinship. There is no place in a tribe for any person whose kinship is not fixed, and only those persons can be adopted into the tribe who are adopted into some family with artificial kinship specified. The fabric of Indian society is a complex tissue of kinship. The warp is made of streams of kinship blood, and the woof of marriage ties.

With most tribes military and civil affairs are differentiated. The functions of civil government are in general

differentiated only to this extent, that executive functions are performed by chiefs and sachems, but these chiefs and sachems are also members of the council. The council is legislature and court. Perhaps it were better to say that the council is the court whose decisions are law, and that the legislative body properly has not been developed.

In general, crimes are well defined. Procedure is formal, and forms are held as of such importance that error therein is *prima facie* evidence that the subject matter formulated was false.

When one gens charges crime against a member of another, it can of its own motion proceed only to retaliation. To prevent retaliation, the gens of the offender must take the necessary steps to disprove the crime, or to compound or punish it. The charge once made is held as just and true until it has been disproved, and in trial the cause of the defendant is first stated. The anger of the prosecuting gens must be placated.

In the tribal governments there are many institutions, customs, and traditions which give evidence of a former condition in which society was based, not upon kinship, but upon marriage.

From a survey of the facts it seems highly probable that kinship society, as it exists among the tribes of North America, has developed from connubial society, which is discovered elsewhere on the globe. In fact, there are a few tribes that seem scarcely to have passed that indefinite boundary between the two social states. Philologic research leads to the same conclusion.

Nowhere in North America have a people been discovered who have passed beyond tribal society to national society based on property, *i. e.*, that form of society which is characteristic of civilization. Some peoples may not have reached kinship society; none have passed it.

Nations with civilized institutions, art with palaces, monotheism as the worship of the Great Spirit, all vanish from the priscan condition of North American in the light of an-

thropologic research. Tribes with the social institutions of kinship, art with its highest architectural development exhibited in the structure of communal dwellings, and polytheism in the worship of mythic animals and nature-gods remain.

TWENTY-SEVENTH REGULAR MEETING.

OCTOBER 5, 1880.

Scheme of the Tenth Census for the Enumeration of Untaxed Indians.

By GARRICK MALLERY.

The speaker exhibited the schedule prepared by the Bureau of Ethnology for this purpose and explained the object of the inquiries made therein.

Ossuary at Accotink, Va.

By E. R. REYNOLDS.

This ossuary was discovered on the 15th of April, 1869, by a party of gentlemen from the Shenandoah Valley. It is situated on the farm of Lewis Ashton, Esq., Fairfax County, near the confluence of Accotink Creek and the Potomac, at Marlborough. The cutting of its banks by the creek revealed human remains and implements. Mr. Printz and other members of the party succeeded in recovering the bones of twelve very large Indians. They had been buried with their feet to the east under a stratum of earth six feet deep. The skeletons appeared to be between six and seven feet long, and correspondingly large in other respects.

Around the head of one of the skeletons were four oblong shells set vertically in the soil and lapping past each other like the scales of a fish. Each shell was about six inches long by four inches wide. A human face in tolerably high relief, was carved upon each, and also five grooves or "tallies." In addition to these, a fifth shell was found lying near the head. It was about four inches in diameter and nearly circular in shape, with a rudely carved human face on the sand in tolerably high relief. Next to this semi-circle of shells were found four round shells smoothly carved and polished. Each was about four inches in diameter, and had several perforations. Another perforated shell was found; this, however, was only an inch and a half in diameter. Next, six circular disks of copper were discovered, ranging from two and a half to six inches in diameter. These were also perforated like the shells. In another direction they unearthed six oblong plates of copper, ranging from three to four inches in width and from five to seven inches in length. Four small shells, each about four inches in length were found in another pile near the central skeleton, and near by about four quarts of beads made of rolled copper cylinders, bone, clay, and shell. The copper beads were from one and a half to two inches long, and were strung upon what appeared to be a thread having a coarse linen texture. The thread was in a good state of preservation, and the fragments exhibited still show the character of the material used.

In another part of the mound or ossuary six small triangular pieces of copper were found, two earrings made of rolled brass tubes, a beautiful pipe made of stone with copper ornaments attached, and other finely finished stone pipes. Two small copper bells shaped like modern sleigh-bells and an earthen dish were found in rear of the head and other objects named. A cross of white metal of rude construction was found in an erect position, sustained by the earth, between the thumb and fore-finger of the skeleton. The other eleven skeletons had nothing about them but beads. All were in an excellent state of preservation. The mound

has been washed entirely away by the freshets, and nothing remains to mark its former position.

TWENTY-EIGHTH REGULAR MEETING.

OCTOBER 19, 1880.

An Inquiry Into the History and Indentity of the Shawnee Indians.

BY C. C. ROYCE.

Mr. Royce said his paper should be considered as merely tentative and subject to corrections of either a minor or radical character as the results of future inquiries may justify.

The Shawnees were the Bedouins and one may almost say the Ishmaelites of the North American tribes. As wanderers they were without rivals among their race, and as fomenters of discord their genius was marked. Their original home is not certainly known. It is not probable that it ever will be. 1st. In the year 1608, Captain John Smith, of Virginia, in voyaging up the Chesapeake found the neighboring tribes living in dread of a tribe known to them as "Massawomekes," who lived beyond the mountains, whence the Potomac River has its sources, upon a great salt water or lake. He encountered seven canoes full of them at the head of the bay and remarks that their dexterity in their canoes, made of the bark of trees, and well luted with gum, gave evidence of their residence upon some great water.

Smith's map of 1629, locates the Massawomekes upon the south shore of a supposed large body of water in about the direction and location of Lake Erie.

Gallatin and Bancroft have assumed that the Massawomekes and the Five Nations were identical. In contradiction of this is the fact that at the date of Smith's travels, the most westerly of the Five Nations—the Seneca—was not in possession of the country west of the Genesee River. From that

river westward to and beyond Niagara River resided a nation known to history as the Attiwondaronk, or Neuter Nation, who were not defeated and dispersed by the Five Nations until 1651, more than forty years subsequent to Smith's observations. To reach the country of the latter from Chesapeake Bay the Susquehanna River would have been the most natural course to pursue. The Massawomekes returning home pursued a northwest direction beyond the mountains which would have been an unnatural and inconvenient route to reach the country of the Five Nations. It is assumed, then, that the Massawomekes occupied the south and southwest shore of Lake Erie and controlled the country from there to the Alleghany mountains.

2d. During the first half of the seventeenth century there existed on the south shore of Lake Erie in the identical territory above assigned to the Massawomekes, a nation of Indians known as the "Eries," "Rique," or "Chats." The Jesuits visited them as early as 1626, and were unsuccessful in attempting to establish missions among them. They were overthrown and dispersed by the Five Nations about 1655, and no subsequent mention is made of them as a nation.

3d. Colden in his history of the Five Nations relates that shortly prior to the French settlement of Canada, the Five Nations had been driven by the Andirondacks, from the neighborhood of Montreal to the banks of the lakes on which they subsequently lived. There they turned their arms against the "Satanas" who lived to the west of them on the banks of the lakes, and in a few years subdued and drove them from the country. This relation is doubtless borrowed from the narrative of Nicholas Perot, who lived among the Indians for more than thirty years subsequent to 1665. These "Satanas" are mentioned by Colden as synonymous with the "Shaonons," or, as Perot calls them, "Chaoua nons."

Here, then, we have in the earliest history of the country the names of three tribes who by the accounts of different

and widely separated travelers, occupied the same region of country, viz.:

1st. The "Massawomekes" of Smith.

2d. The "Eries," or "Chats," of the Jesuit relations, and

3d. The "Satanas" of Colden, and "Chaouanons" of Perot.

By all accounts given of these people they were numerous and powerful. Each occupied and controlled a large region of territory in the same general locality; each had so far as known long been the occupant thereof. Neither of the authorities cited speaks of more than one nation occupying this region; neither seems to have had any knowledge or tradition of any other nation having done so. It is improbable that three numerous and warlike nations should within the historic period have occupied so limited a region without any account or tradition having survived of their intercourse and conflicts with each other. These facts constitute strong evidence that three such distinct nations never had a contemporaneous existence, and that the Masswomekes, Eries, and Satanias or Chaouanons, were one and the same people.

This identity having been assumed, and the Eries having by all accounts been conquered and dispersed about 1655, it remains to trace the remnant in their wanderings, which is a most difficult and unsatisfactory task.

It may be remarked at this point that a manuscript map still exists in Holland of the date of 1614 or 1616, whereon a nation of Indians called "Sawwoaneu" is marked as living on the east bank of Delaware River. De Laet, also, in his history (edition of 1640) enumerates the "Sawanoos" as one of the tribes then inhabiting the Delaware River. Vanderdonck's map of New Netherlands, dated 1656, assigns the "Sauwanoos'" position on the west bank of the Zuydt (now Delaware) River, between the present sites of Philadelphia and Trenton.

It is not impossible that, during the conflicts between the Satanias and Five Nations, a body of the former may have

become segregated from their friends and terminated their wanderings by a settlement on the Delaware.

The Eries being overthrown, the survivors driven from their ancient homes and deprived of the lake as a principal source of food supply, were forced to resort more extensively to the chase as a means of subsistence, the tendency of which would be to divide the tribe into small hunting parties, and encourage the wandering propensities so often remarked of the Shawnees.

In 1669 a Shawnee prisoner offered to guide La Salle from Lake Ontario to the Ohio River, with which region he (the Shawnee) was familiar and in which he probably resided. The "Illinois" informed Marquette, in 1670, that the "Chaouanons" lived thirty days' journey southeast of their country.

In 1672, Father Marquette locates the "Chaouanons" on the Ohio River in twenty-three villages. In 1680 a "Chaouanon" chief, living on a great branch of the Ohio, sent to La Salle to form an alliance.

The map accompanying Marquette's journal, published in 1681, locates the "Chaouanons" on the Ohio River, near the Mississippi; but on his original manuscript map they are located in a vast unexplored region far to the east of the Mississippi, in about the latitude of the middle or upper Ohio.

In 1682, La Salle took possession of the country east of the Mississippi, from its mouth to the Ohio, with the consent of the "Chaouanons," "Chichachas," *et al.*

"Joutel," the companion of La Salle, remarks that the Shawanoes "formerly lived on the borders of Virginia and the English colonies."

Father Gravier, in 1700, speaks of the "Chaouanoua" as living upon a main branch of the Ohio, coming from the S. S. W.

De Lisle's map of 1700 places the "Ontouagannha" (a Jesuit synonym for Shawnee) on the headwaters of the Santee and Great Pedee rivers, in South Carolina, and the "Chiononons" on the Tennessee River, near its mouth. A portion

of this band of "Ontouagannha" getting into trouble with their neighbors, came up to Pennsylvania with the consent of the Susquehannocks, and settled at Conestoga in 1698. Four years earlier a few of this band had, at the request of the "Minsis," been allowed to settle on the Delaware River among the latter. Other straggling parties joined these bands from time to time, rendering the Shawnees at last quite numerous and powerful in Pennsylvania.

John Senex's map of North America, of 1710, indicates villages of "Chaouenons" on the headwaters of South Carolina, but apparently locates the main body along the upper waters of the Tennessee River.

"Moll's" map of 1720 does not indicate the presence of any Chaouanons on the Tennessee River, but covers their former territory with "Charakeys." This bears out the story of the French trader mentioned in Ramsey's Tennessee, who was among the Shawnees on Cumberland River, in 1714, and says that about this time they were expelled by the Cherokees and Chickasaws. On this map of Moll's is found, at the mouth of the Cumberland (or Sault) River, the words "Savannah Old Settlement," indicating probable abandonment, a few years prior, in their gradual withdrawal to the north side of the Ohio River.

Prior to 1714, a band of "Chaouanons," probably wanderers from the Cumberland and Tennessee country, lived for a short time within two leagues of the fort at Mobile, Ala.

Another band, likely an offshoot from the South Carolina faction, found a home at Oldtown, Md., a few miles below Cumberland, and was doubtless the band with whom William Penn concluded a treaty, in 1701 at Philadelphia.

Between the ejection of the Shawnees from the Cumberland and Tennessee valleys and the middle of the eighteenth century, their appearance in history is rare. They doubtless occupied portions of Ohio and Indiana. Emanuel Bowen's map, published in 1752, locates a "village de Chouanons" on the north side of the Ohio River, midway between the mouths of the Kanawha and Scioto. That branch of the

tribe in Pennsylvania, meanwhile, became the most numerous and important portion of the Shawnee people. Owing to the encroachments of the white population, they were gradually forced back until, about 1750, they began a migration to the Ohio country, where they united with their western brethren. They aided the French in the war of 1755, especially at Braddock's defeat.

In 1756 an expedition against them under Major Lewis was a failure. In 1764, Colonel Boquet's expedition resulted in temporary peace with them. In 1774 they were defeated, with their allies, at Point Pleasant, Va. In 1780, General George Rogers Clarke burnt their towns on Mad River, and in 1782 repeated it on the Miami. In 1790 and 1791 they participated in the defeats of Generals Harmar and St. Clair respectively. In 1794 they, with others, were defeated by General Wayne, and were parties to the treaty of 1795, whereby the southern two-thirds of Ohio and a portion of Indiana were ceded to the United States. They have been parties to numerous treaties since that date, whereby their claims to territory have been gradually relinquished.

In the interval between Wayne's treaty and the war of 1812, the Shawnees again became hostile, and the forces of Tecumseh, under command of his brother, the prophet, were defeated at Tippecanoe, in 1811, while Tecumseh himself was killed at the battle of the Thames, in 1813.

By the treaty of 1817, three small tracts were reserved for the occupancy of the Shawnees in northwestern Ohio, which were in turn ceded to the United States, in 1831, preparatory to their removal west of the Mississippi River. A reserve was provided for the mixed Senecas and Shawnees in Indian Territory, where they now reside, and another in Kansas for the Shawnees alone, to which, in company with a portion of their people, who had been living in Missouri since 1793, they removed and again became united. A portion of this reserve was ceded to the United States, in 1854, and in 1869, after having sold the remainder of their lands in Kansas, they removed to Indian Territory, and merged

their tribal existence with the Cherokees. A number of Shawnees who, just prior to and during the late rebellion, wandered off to Texas and Mexico, returned after the war and were provided with a separate home in Indian Territory, under the name of "Absentee Shawnees." These latter, together with those confederated with the Senecas in the northeastern part of Indian Territory, are all of the once powerful "Massawomekes" now left to maintain the tribal name of "Shawnee."

Civilization.

By M. B. W. HOUGH.

The aim of this paper seemed to be chiefly to enforce the truth which is embodied in the adage, *cælum non animus mutant qui trans mare currunt*. There is a succession of qualities practically parallel with the current of life. Culture to be successful with a people must be adapted to their character. The mere communication of knowledge will not civilize a race. Civilization must be inherent and therefore of slow development. So long as the features of the ancestor are repeated in his descendants, will the traits of his character reappear. Language may change, customs be left behind, races may migrate from place to place, and subsist on whatever the country they occupy affords, but their fundamental characteristics will survive, these are comparatively uninfluenced by the mere accidents of nutrition.

Mr. Hough then proceeded to consider some of the elements of civilization, among which he recognizes marriage, war, slavery, caste, a measure of value, money, &c., each of which he treated at length. Any form of marriage is better than no marriage; polygamy even has its advantages as a system of marriage. War laid the foundation for landed proprietorship, which, whatever its present or future evils, has been in the past a powerful engine of progress. Slavery even

has played a part in civilization and lies at the bottom of the industrial social state. Indirectly, too, slavery has been beneficial. The most unnatural forms, as for example that formerly existing in the United States, have upon the whole worked to the advantage of the slave. Caste in India led to the division of labor; in feudal Europe it led to political organization. Money and the conception of property mark a great stride in social progress:

The speaker gave as the true tests of civilization: 1. The degree to which the powers of nature are made conducive to the well-being of man; and 2, the degree to which man has learned to conform to the laws of nature. He would exclude from the true civilizing agencies the ceremonial part of social existence, the forms of religion, and much that passes for culture. The remainder of the paper was devoted to the elaboration and historical illustration of these general principles.

TWENTY-NINTH REGULAR MEETING.

NOVEMBER 2, 1880.

No quorum present, by reason of the National election.

THIRTIETH REGULAR MEETING.

NOVEMBER 16, 1882.

Tuckahoe, or Indian Bread.

By J. H. GORE.

The speaker first mentioned the circumstances which suggested this subject for investigation, and the unsettled condition of the various theories concerning its nature and use.

The early writers attributed to Tuckahoe great nutritive qualities; so in order to determine its exact value as an ar-

tie of sustenance for the Indians, it was necessary to ascertain the geographic distribution of Tuckahoe, and its prevalence in these localities. This was accomplished by sending circulars of inquiry through the Smithsonian Institution to nearly every Cryptogamic Botanist in the United States, to Curators of Natural History Museums and to the newspapers along the Atlantic coast and the Mississippi Valley. It was found that it was more or less abundant in the Coast States from New Jersey to Florida, and in Kansas and Arkansas. The question: Did its growth depend upon circumstances then existing? was answered by giving an outline of the process of its development, and specimens were exhibited by way of proof.

Likewise the means by which it might have been found by the nations if its value as food was sufficient to pay for the trouble. Its exact nutritive value was determined by an analysis made by Dr. Parsons, which gave only three-fourths of one per cent. of nitrogenous matter; this being insufficient to repair the waste in the animal tissues it was pronounced valueless as food. The speaker then suggested that there must have been other roots called Tuckahoe, and quoted from a number of histories showing that a root by this name was frequently described entirely different from the one in question; and finally succeeded in identifying five roots which were once known as Tuckahoe. Also the derivation of the word Tuckahoe given the speaker by the distinguished Ethnologist, Dr. Trumbull, shows that it is from *ptuckqui*, meaning something round or rounded, and not from a word meaning bread, as heretofore supposed. The conclusion then given was, that Tuckahoe was a term applied to *all* roots which were made esculent by cooking. Finally, all of these except *Pachyma coros* received a special name, this alone retaining the appellation of Tuckahoe, and that when we read of Tuckahoe as contributing so largely toward the support of the aborigines we can only know that all edible tubers were referred to. The paper was illustrated by six large charts giving twelve botanic synonyms, eight affinities,

five roots, once known as Tuckahoe; an analysis, one of these showing that it was nutritive; ten Indian synonyms, and an analysis of Tuckahoe.

Indian Mounds in the Shenandoah Valley.

By E. R. REYNOLDS.

Mr. Reynolds read a paper on an Indian Mound, nine miles southwest of Luray, in the Valley of the South Shenandoah. The mound is situated at the eastern base of the Massaunutton Mountain, on the farm of Mr. Phillip Long. It was, according to Kercheval, originally about twelve or fourteen feet high by thirty feet in diameter. It is now but two and a half feet high. In opening the mound a stratum of hard, fire-baked clay was found at the bottom, on which reposed the remains of the Indian to whose memory the mound was erected. Around the remains were found a large and miscellaneous collection of ornaments and weapons, many of which were seriously injured by the cremation fire.

THIRTY-FIRST REGULAR MEETING.

DECEMBER 7, 1880.

Superstitions.

By A. S. GATSCHE.

This phase of the human mind manifests itself in so many ways that the definitions given by Webster and others do not cover the whole ground. It is a belief in a known or unknown physical power operating within us or outside of us, and having a supernatural influence upon our bodies or our minds, in such a manner that the future may be foreseen and its events controlled.

The causes of superstition are egotism and the instinct of self-preservation. The forces of nature and its phenomena

can work us good or harm, and influence over them will give us an advantage over our fellow beings.

The religions of the world are connected more or less with superstition, many of the Pagan forms of worship containing little or nothing else. The peculiar garb in which it clothes itself is the badge or mark of a certain grade of civilization. As it progresses in its evolution it becomes more and more connected with morality.

The speaker then discussed at length the subjects of symbolism, dreams, astrology, augury, prognostics, cheiromancy, superstitions referring to animals, plants, and the occupations of life.

Superstitions are to be numbered by the million. Every year old ones die, new ones arise. Ignorance of the true causes of things, and an innate desire to account for them, lead all peoples to render a reason which is on a plane with their intelligence.

The folk-lore societies and many private individuals are engaged in collecting these fabulous stories. They are of scientific value only as they lead to a deeper insight into the psychology of those who believe in them. In the collection of them the most profound sympathy must exist between the student and his subject. Properly understood they contribute to the advancement of ethnology, psychology, and linguistic science.

Mr. Gatschet then proceeded to give some examples of superstition gathered from our North American Indians, dividing his subject as follows:

- I. Superstitions connected with hunting.
- II. Superstitions connecting with fishing.
- III. Those connected with daily life, as sneezing, combing the hair, eating, dreaming, journeying, barrenness, observance of days, tabu, medicine.
- IV. Those connected with certain species of natural objects, as stormy petrels, gulls, wild geese, bears, foxes, ants, totemic animals.
- V. Those connected with extraordinary phenomena, as

meteors, northern-lights, eclipses, great floods, lightning, bleeding at the nose, the birth of twins, lucky numbers.

In order to show the scope of the paper a few of the superstitions given are subjoined:

The Indians on the Huallaga (S. Am.) injures his *sarbacane* by shooting at a certain small yellow bird, and by discharging his arrow at a snake he will make the blow-tube as crooked as the snake itself.

Among a great variety of tribes widely separated, silence is enjoined during the hunt.

The Cholos purge themselves severely and remain in the hammock until the moon changes, before a great hunt.

To become a good hunter you must kill a cougar, or grizzly bear, or eat the heart of a rattlesnake or of a slain enemy.

Whale-fishers of Alaska keep the bodies of celebrated hunters in caves. When they are about to go on a whaling cruise they put these corpses in water and then drink it so as to acquire great skill and prowess.

Sneezing is a sign that some one is thinking of you. Combing the hair after dark is a sign that one of our parents will not live long. Only old persons comb their hair in the evening.

Dreaming of hides always is a prognostic of great wealth.

If your shadow falls on a hill you will find no edible roots.

The Modocs will not kill a white deer unless there are many persons present.

On the Colorado River a meteor flying west is the "big man's" heart hastening to the ocean.

The polar light is among many tribes the dance of the dead.

In the double rainbow the faint arch is the grandmother of the bright one.

Among the Salinas (S. Am.) twins are the evidence of illicit intercourse, and the woman is punished.

THIRTY-SECOND REGULAR MEETING.

DECEMBER 21, 1880.

Savage and Civilized Orthöepy.

BY LESTER F. WARD.

This paper consists principally of remarks and strictures on the first chapter of the *Introduction to the Study of Indian Languages*.*

After quoting a preliminary paragraph from this work relating to the complexity and vagueness of the sounds in savage languages, Mr. Ward said that the two leading facts enunciated in it were: 1st, the multiplicity of sounds which the human races have embodied in speech; and 2d, the existence and prevalence of pseudo-sounds or the unstable forms of vocalic and articulate utterance which the author of the work quoted from designates as "synthetic or undifferentiated sounds." He claimed that philologists had failed sufficiently to recognize these two fundamental elements of linguistic study and proceeded to show from numerous examples drawn from the French, German, Italian, Spanish and English languages that these characteristics, so far from being confined to savage or barbaric tongues are common to all languages even the most cultured. The most general fact adduced in support of this view was that all foreigners in learning another language pronounce it at first, and generally always, with an "accent" peculiar to their vernacular, and that this accent is often the most marked in sounds which all the books teach to be common to both languages; as in the attempt of Germans to pronounce the English word "will."

He accounted for the multiplicity of languages on the globe on strictly natural principles. The facts of phonology not less than those of morphology are the result of origi-

* *Introduction to the Study of Indian Languages*, by J. W. Powell, Washington, 1880; 4°.

nally fortuitous circumstances followed by strictly mechanical adaptation to the infinitely varying conditions of existence. The truth should be clearly recognized that there is no fixed limit to the number and variety of sounds which speech may embrace except that which the capacity of the organs of speech for producing such sounds presents. If all the adjustments of which these organs are capable could be definitely known and accurately described in terms of the mechanical changes necessary to produce them, and each such *species* of sound, as we may say, were then conveniently named according to the methods of science, then the various syllables of a new language might be referred to established orders and classes, genera and species, and the science of phonology historically established. It might then be seen how utterly fortuitous the character of every language has been within the limits of its possibilities, and the immense diversity of languages, not in their word-units and sentence-units alone, but in their sound-units as well, would be no more inexplicable than are the variations which we see in animal and plant forms. The primary principle in acquiring a foreign pronunciation is to learn and to adopt the accurate position of the organs of the mouth; in fact, could this in all cases be done, failure to pronounce correctly would be a physical impossibility, since the sound is in each case the mechanical result of the relations of the speaking organism and can no more differ from the character fixed by these relations than the pitch or *timbre* of a musical instrument can be other than that which its strings, keys, materials, &c., require it to be.

Mr. Ward then took up the letters and commented upon a considerable number of them with a view to pointing out undifferentiated sounds in modern languages, and also in order to emphasize certain errors into which different lexicographers have fallen and certain failures on their part to recognize distinctions almost universally made by English-speaking people. This was particularly striking in certain letters mentioned.

Vowels : *a*. What is called the short *a* in the French is a typical synthetic sound varying in the mouths of different speakers, even the best instructed, from that which it has in the English word *add* to the Italian sound as heard in *father*, which is scarcely more than a lengthening of the sound it acquires in the word *what* (equal to *o* in *not*), and fairly reaches this latter sound when heard in *pas*. In English, too, the *a* is sometimes of a very uncertain character, especially in such words as *last*, *glass*, *path*, &c.; also in such words as *bad*, *glad*, *mad*, *chaff*, *lag*, *salve*, *damp*, *rank*, *grant*, *gap*, *care*, *gas*. On these points lexicographers differ widely, and, as the speaker believed, much more widely than the public. The difficulty in most cases was held to be due chiefly to the imperfect discrimination by lexicographers of sounds which nearly all clearly distinguish in pronouncing, but which even those who do so can rarely recognize as unlike when the differences are pointed out by another. The only three authors who seem to have clearly perceived the true sound of *a* in the examples given are Fulton & Knight and Smart. All others, including Webster, Worcester, Walker, Johnston, Reid, Nares, Jameson, Sheridan, Perry, Knowles, Jones, and Craig, whose views had been carefully examined by the speaker, had denoted the sound of this letter in these circumstances by symbols which would, if followed, entirely alter the pronunciation of the English language.

Relative to the sound of the English *i*, while admitting of course that the long sound as heard in *mind* is a true diphthong, equivalent to the Italian sound of *a* followed quickly by the English long *e*, it was maintained that the English short *i*, as in *bit*, &c., is not a mere shortening of the continental *i*, but is a distinct sound which can be indefinitely prolonged without change or tendency to assimilate that sound.

To pass from the one sound to the other was shown to require a slight readjustment of the organs of the mouth.

- o*. There is one sound of the English *o* which is clearly synthetic, viz., that heard in the word *whole*; but this is the only word to which it applies, and uninstructed people vary it through the entire range of sounds from that of the *u* in *hull* to that of the *o* in *hole*. In French, however, this is the prevailing sound of the *o* and constitutes their short or unaccented *o*. It is there highly synthetic, being pronounced quite differently in different sections of France, and in the same section by different persons, and even in different words by the same person, cultivated as well as uncultivated. Numerous examples were given by the speaker.

The disagreements and misconceptions among lexicographers relative to this letter were shown to be similar to those in the case of the *a*, all of whom, for example, with the exception of Smart, give it the same sound in the words *dog*, *loss*, *moss*, *cloth*, &c., as in the words *not*, *pod*, *bog*, &c. The speaker maintained that the former sound is identical with that of the *au* in *fraud*, or the *aw* in *law*.

- u* Great misapprehension exists with regard to the long sound of the *u*, whether to give it in any case the Continental sound represented by *oo* in English, or to make it a diphthong as in *blue* (= *blew*) consisting of the short sound of *i* prefixed to that sound. The word *rule* which Maj. Powell selects as the type of the former pronunciation is much more frequently given the latter, though this seems not to be sanctioned. The short sound of the *u* as in *pull* was held to be, like the short sound of *i*, a distinct sound capable of indefinite prolongation.

Diphthongs: The speaker maintained that there were gradations among the diphthongs according to the sounds given to the components which would considerably increase the number given by Major Powell. For example, besides the *ai* (mine) there may be *âi*, and besides *au* there may be both *âu* and *êu*, which last is more nearly the common pronunciation of the *ow* in *down*, the example given by him, and which is quite distinct from the German *au* as in *haus*. Only broad-spoken people give this sound in English. There are also gradations between the *ai* and the *âi* as exemplified by the German *eu*, *heute*, and *äu*, *häuser*. On the Continent the chief distinction is in the degree to which the two sounds are kept separate. In Italian and Spanish the combination in *au* is not regarded as a diphthong, the two letters constituting as many syllables.

Consonants: Mr. Ward next proceeded to remark upon certain of the consonants. The German *b* and *p*, *k* and *g*, as also to some extent *s*, *t*, and *d*, he regarded as synthetic. The Germans simply take no account, in pronouncing these letters, of the distinction between *surd* and *sonant*, they do not know in speaking whether they vocalize them or not. This exemplifies a principle which students of language should understand, viz., that in some languages *there are processes ignored in utterance*. Another example of this is found in the cockney pronunciation of *h*, where it does not belong and omitting it where it should be heard. It is simply ignored and whether a word receives an aspiration or not depends upon rhetorical rather than orthographical considerations.

There is no line of demarkation between the aspirate and the guttural. Several steps of this interval are filled by the Spanish *j*, *g*, and *x*, and by the two sounds of the German *ch*.

It was maintained that the trilled *r* should not be confounded with the English *r*. The latter is *sui generis*. In the former, besides the distinctive vibratory motion of the tongue, it is placed much farther forward, in a position which is about the same as that required for the pronunciation of *l*, and to which sound, therefore, this is really more nearly allied than to that of the English *r*.

The sibilate sound *s* varies greatly in different languages, the tongue assuming a position farther and farther forward in pronouncing it, until it finally passes, in the Spanish *c* and *z*, into the *th* of the English.

The German *w* and Spanish *v* are not, like the English *v*, dento-labials, but pure labials, and much nearer allied to *b* than to *v*. In the former the lips are not allowed to come into contact, and air is passed between them, giving a sound resembling that of our *v*, but organically wholly distinct from it. In the latter the *v* and the *b* are not only to a large extent confounded in sound, but also in orthography, as is evidenced by the large number of words which are indifferently written with the one or the other letter—e. g. *bacia* or *vacia*, *baho* or *vaho*, *bulto* or *vulto*, &c.

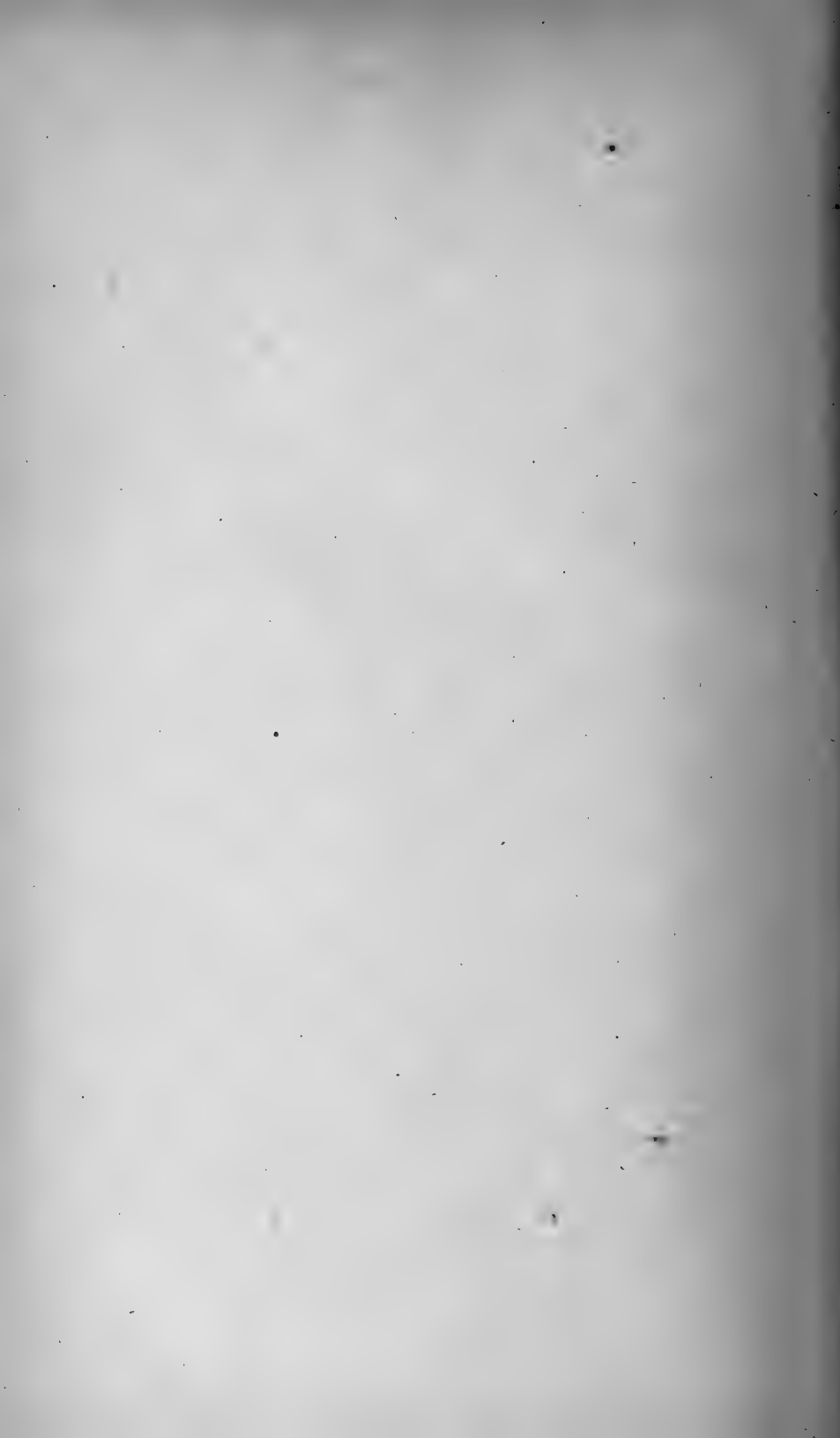
THIRTY-THIRD REGULAR MEETING.

JANUARY 4, 1881.

No quorum present, by reason of a storm.

ANNUAL MEETING FOR THE ELECTION OF OFFICERS.

JANUARY 18, 1881.



ANNUAL ADDRESS OF THE PRESIDENT, J. W. POWELL.

1881.

On Limitations to the use of some Anthropologic Data.

GENTLEMEN :

The Constitution of the Anthropological Society of Washington makes it obligatory upon its President to deliver an address at the first meeting in February, upon the work of the Society during the preceding year.

Last year it had escaped the notice of the President that his annual address was limited to a specified topic, and he prepared for that occasion a paper on the "Evolution of Language." As his mistake was not discovered in time, he was permitted, through the courtesy of the society, to read the address prepared, with the understanding that at some subsequent time the review provided by the Constitution should be presented by him. It thus occurs that the transactions of the society for a period of two years are embraced in the present address.

In preparing the present paper under the restrictions imposed by the Constitution, it has been found difficult to give an intelligent account of the subject-matter coming from time to time before the society, while the papers thereon were yet unpublished; and it was finally concluded to be the better way to prepare an abstract of the several papers and to follow with remarks upon the subject-matter therein presented.

In executing this plan the President's address of last year is incorporated.

In making these abstracts your President has attempted to seize the more important facts and conclusions presented,

and, to a large extent, has been compelled to do this in his own language. If injustice is done in any case by failure properly to appreciate the author, in palliation the President begs of gentlemen to believe that he has earnestly tried to do justice to each.

In reviewing the work of the past two years the papers are used as suggestive of a line of remarks rather than as objects of criticism.

Archæology.

On the Antiquities of the United States papers have been read, as follows:

RELIC HUNTING; by Frank H. Cushing.

OBSERVATIONS ON AZTEC AND GUATEMALAN ANTIQUITIES; by Otis T. Mason.

ARROW-HEAD MAKING; by Frank H. Cushing.

PROGRESS OF ARCHÆOLOGIC RESEARCH IN THE UNITED STATES; by Wills De Hass.

ABORIGINAL PAINT QUARRY; by Elmer R. Reynolds.

ABORIGINAL CEMETERIES NEAR PISCATAWAY, MD.; by Elmer R. Reynolds.

ON THE ABORIGINAL SHELL-HEAPS AT POPE'S CREEK, MD.; by Elmer R. Reynolds.

Letter read by Mr. Riley.

TURTLE-BACK CELTS AND THEIR USES; by Elmer R. Reynolds.

SHELL-HEAPS OF SOUTH RIVER, MARYLAND; by J. D. McGuire.

THE MOUND-BUILDERS; AN INQUIRY INTO THEIR ASSUMED SOUTHERN ORIGIN; by Wills De Hass.

DUMBARTON ABORIGINAL SOAPSTONE QUARRY; by Elmer R. Reynolds.

OSSUARY AT ACCOTINCK, VA.; by Elmer R. Reynolds.

INDIAN MOUND IN THE VALLEY OF THE SHENANDOAH; by Elmer R. Reynolds.

Investigations in this department are of great interest, and have attracted to the field a host of workers; but a

general review of the mass of published matter exhibits the fact that the uses to which the material has been put have not always been wise.

In the monuments of antiquity found throughout North America, in camp and village sites, graves, mounds, ruins, and scattered works of art, the origin and development of art in savage and barbaric life may be satisfactorily studied. Incidentally, too, hints of customs may be discovered, but outside of this, the discoveries made have often been illegitimately used, especially for the purpose of connecting the tribes of North America with peoples or so-called races of antiquity in other portions of the world. A brief review of some conclusions that must be accepted in the present status of the science will exhibit the futility of these attempts.

It is now an established fact, that man was widely scattered over the earth at least as early as the beginning of the quaternary period, and, perhaps, in pliocene time.

If we accept the conclusion that there is but one species of man, as species are now defined by biologists, we may reasonably conclude that the species has been dispersed from some common centre, as the ability to successfully carry on the battle of life in all climes belongs only to a highly developed being; but this original home has not yet been ascertained with certainty, and when discovered, lines of migration therefrom cannot be mapped until the changes in the physical geography of the earth from that early time to the present have been discovered, and these must be settled upon purely geologic and paleontologic evidence. The migrations of mankind from that original home cannot be intelligently discussed until that home has been discovered, and further, until the geology of the globe is so thoroughly known that the different phases of its geography can be presented.

The dispersion of man must have been anterior to the development of any but the rudest arts. Since that time the surface of the earth has undergone many and important

changes. All known camp and village sites, graves, mounds, and ruins, belong to that portion of geologic time known as the present epoch, and are entirely subsequent to the period of the original dispersion as shown by geologic evidence.

In the study of these antiquities, there has been much unnecessary speculation in respect to the relation existing between the people to whose existence they attest, and the tribes of Indians inhabiting the country during the historic period.

It may be said that in the pueblos discovered in the southwestern portion of the United States and farther south, through Mexico and perhaps into Central America, tribes are known having a culture quite as far advanced as any exhibited in the discovered ruins. In this respect then, there is no need to search for an extra-limital origin through lost tribes for any art there exhibited.

With regard to the mounds so widely scattered between the two oceans, it may also be said that mound building tribes were known in the early history of discovery of this continent and that the vestiges of art discovered do not excel in any respect the arts of the Indian tribes known to history. There is, therefore, no reason for us to search for an extra-limital origin through last tribes for the arts discovered in the mounds of North America.

The tracing of the origin of these arts to the ancestors of known tribes or stocks of tribes is more legitimate, but it has limitations which are widely disregarded. The tribes which had attained to the highest culture in the southern portion of North America are now well known to belong to several different stocks, and if, for example, an attempt is made to connect the mound-builders with the Pueblo Indians no result beyond confusion can be reached until the particular stock of these village peoples is designated.

Again, it is contained in the recorded history of the country that several distinct stocks of the present Indians were mound-builders and the wide extent and vast number of mounds discovered in the United States should lead us to

suspect, at least that the mould-builders of pre-historic times belonged to many and diverse stocks. With the limitations thus indicated the identification of mould-building peoples as distinct tribes or stocks is a legitimate study, but when we consider the farther fact now established that arts extend beyond the boundaries of linguistic stocks, the most fundamental divisions we are yet able to make of the peoples of the globe, we may more properly conclude that this field promises but a meager harvest; but the origin and development of arts and industries is in itself a vast and profoundly interesting theme of study, and when North American archaeology is pursued with this end in view, the results will be instructive.

Picture Writing.

On this subject three papers have been presented, as follows:

SOME INDIAN PICTOGRAPHS; by G. K. Gilbert.

INDIAN PICTOGRAPHS; by G. K. Gilbert.

INDIAN PICTOGRAPHS IN NEW MEXICO; by Miles Rock.

The pictographs of North America were made on divers substances. The bark of trees, tablets of wood, the skins of animals and the surfaces of rocks were all used for this purpose; but the great body of picture-writing as preserved to us is found on rock surfaces, as these are the most enduring.

From Dighton Rock to the cliffs that overhang the Pacific, these records are found—on boulders fashioned by the waves of the sea, scattered by river floods, or polished by glacial ice; on stones buried in graves and mounds; on faces of rock that appear in ledges by the streams; on cañon walls and towering cliffs; on mountain crags and the ceilings of caves—wherever smooth surfaces of rock are to be found in North America, there we may expect to find pictographs. So widely distributed and so vast in number, it is well to know what purposes they may serve in anthropologic science.

Many of these pictographs are simply pictures, rude etchings, or paintings, delineating natural objects, especially an-

imals, and illustrate simply the beginning of pictorial art; others we know were intended to commemorate events or to represent other ideas entertained by their authors; but to a large extent these were simply mnemonic—not conveying ideas of themselves, but designed more thoroughly to retain in memory certain events or thoughts by persons who were already cognizant of the same through current hearsay or tradition. If once the memory of the thought to be preserved has passed from the minds of men, the record is powerless to restore its own subject-matter to the understanding.

The great body of picture-writings is thus described; yet to some slight extent pictographs are found with characters more or less conventional, and the number of such is quite large in Mexico and Central America. Yet even these conventional characters are used with others less conventional in such a manner that perfect records were never made.

Hence it will be seen that it is illegitimate to use any pictographic matter of a date anterior to the discovery of the continent by Columbus for historic purposes; but it has a legitimate use of profound interest, as these pictographs exhibit the beginning of written language and the beginning of pictorial art, yet undifferentiated; and if the scholars of America will collect and study the vast body of this material scattered everywhere—over the valleys and on the mountain sides, from it can be written one of the most interesting chapters in the early history of mankind.

History, Customs, and Ethnic Characteristics.

On these subjects the following papers have been read:

ANCIENT MAPS OF NORTH AMERICA; by John C. Lang.

ON THE EFFACING POWER OF TROPICAL FOREST-GROWTH IN TRINIDAD ISLAND; by Miles Rock.

ON THE DETERMINATION OF THE AGE OF PREHISTORIC REMAINS; by Edward P. Lull.

A STRANGE CHART; by W. Bainbridge Hoff.

THE INDIAN LAND TITLE—THE METHOD AND CHRONOLOGY OF ITS EXTINGUISHMENT BY THE UNITED STATES; by C. C. Royce.

WHO WERE THE MASSAWOMEKES? by A. L. Guss.

AN INQUIRY INTO THE HISTORY AND IDENTITY OF THE SHAWNEE INDIANS; by C. C. Royce.

SOME MODES OF INDIAN BURIAL; by P. W. Norris.

BURIAL CUSTOMS OF THE NORTH AMERICAN INDIANS; by H. C. Yarrow.

TUCKAHOE, OR INDIAN BREAD; by J.^sH. Gore.

THE USE OF AGRICULTURAL FERTILIZERS BY THE AMERICAN INDIANS AND THE EARLY ENGLISH COLONISTS; by G. Brown Goode.

COLOR-BLINDNESS AS AFFECTED BY RACE; by Swan M. Burnett.

When America was discovered by Europeans it was inhabited by great numbers of distinct tribes, diverse in languages, institutions, and customs. This fact has never been fully recognized, and writers have too often spoken of the North American Indians as a body, supposing that statements made of one tribe would apply to all. This fundamental error in the treatment of the subject has led to great confusion.

Again, the rapid progress in the settlement and occupation of the country has resulted in the gradual displacement of the Indian tribes, so that very many have been removed from their ancient homes, some of which have been incorporated into other tribes, and some have been absorbed into the body of civilized people.

The names by which tribes have been designated have rarely been names used by themselves, and the same tribe has often been designated by different names in different periods of its history, and by different names in the same period of its history by colonies of people having different geographic relations to them. Often, too, different tribes have been designated by the same name. Without entering into an explanation of the causes which have led to this condition of things, it is simply necessary to assert that this has led to great confusion of nomenclature. Therefore the student of Indian history must be constantly on his guard

in accepting the statements of any author relating to any tribe of Indians.

It will be seen that to follow any tribe of Indians through post-Columbian times is a task of no little difficulty. Yet this portion of history is of importance, and the scholars of America have a great work before them.

Three centuries of intimate contact with a civilized race has had no small influence upon the pristine condition of these savage and barbaric tribes. The most speedy and radical change was that effected in the arts, industrial and ornamental. A steel knife was obviously better than a stone knife; fire-arms than bows and arrows; and textile fabrics from the looms of civilized men are at once seen to be more beautiful and more useful than the rude fabrics and undressed skins with which the Indians clothed themselves in that earlier day.

Customs and institutions changed less rapidly. Yet these have been much modified. Imitation and vigorous propagandism have been more or less efficient causes. Migrations and enforced removals placed tribes under conditions of strange environment where new customs and institutions were necessary, and in this condition civilization had a greater influence; and the progress of occupation by white men within the territory of the United States, at least, has reached such a stage that savagery and barbarism have no room for their existence, and even customs and institutions must in a brief time be completely changed, and what we are yet to learn of these people must be learned now.

But in pursuing these studies the greatest caution must be observed in discriminating what is primitive from what has been acquired from civilized man by the various processes of acculturation.

Origin of Man.

Two papers have been presented on this subject, namely: ON THE ZOOLOGICAL RELATIONS OF MAN; by Theodore Gill. PRE-SOCIAL MAN; by L. F. Ward.

Working naturalists postulate evolution. Zoologic research is largely directed to the discovery of the genetic relations of animals. The evolution of the animal kingdom is along multifarious lines and by diverse specializations. The particular line which connects man with the lowest forms through long successions of intermediate forms is a problem of great interest. This special investigation has to deal chiefly with relations of structure. From the many facts already recorded, it is probable that many detached portions of this line can be drawn, and such a construction, though in fact it may not be correct in all its parts, yet serves a valuable purpose in organizing and directing research.

The truth or error of such hypothetic genealogy in no way affects the validity of the doctrines of evolution in the minds of scientific men, but, on the other hand, the value of the tentative theory is brought to final judgment under the laws of evolution.

It would be vain to claim that the course of zoologic development is fully understood or even that all of its most important factors are known. So the discovery of facts and relations guided by the doctrines of evolution react upon these doctrines, verifying, modifying, and enlarging them. Thus it is that while the doctrines lead the way to new fields of discovery, the new discoveries lead again to new doctrines—increased knowledge widens philosophy, wider philosophy increases knowledge.

It is the test of true philosophy that it leads to the discovery of facts, and facts themselves can only be known as such; that is, can only be properly discerned and discriminated by being relegated to their places in philosophy. The whole progress of science depends primarily upon this relation between knowledge and philosophy.

In the earlier history of mankind philosophy was the product of subjective reasoning, giving mythologies and metaphysics. When it was discovered that the whole structure of philosophy was without foundation, a new order of pro-

cedure was recommended—the Baconian method—perception must precede reflection; observation must precede reason. This also was a failure. The earlier gave speculations; the later gives a mass of incoherent facts and falsehoods. The error in the earlier philosophy was not in the order of procedure between perception and reflection, but in the method, it being subjective instead of objective. The method of reasoning in scientific philosophy is purely objective; the method of reasoning in mythology and metaphysics is subjective.

The difference between man and the animals most nearly related to him in structure is great. The connecting forms are no longer extant. This subject of research, therefore, belongs to the paleontologists rather than the ethnologists. The biological facts are embraced in the geological record, and this record up to the present time has yielded but scant materials to serve in its solution.

It is known that man highly differentiated from lower animals in morphologic characteristics existed in early quaternary and perhaps in pliocene times, and here the discovered record ends.

Language.

Six papers have been presented on linguistic subjects, namely:

INDIAN COLOR NAMES; by Albert S. Gatschet.

THE SIGN LANGUAGE OF THE NORTH AMERICAN INDIANS; by Garrick Mallery.

A COMPARISON OF A WRITTEN LANGUAGE WITH ONE THAT IS SPOKEN ONLY; by Otis T. Mason.

ON THE EVOLUTION OF LANGUAGE AS EXHIBITED IN THE SPECIALIZATION OF THE GRAMMATIC PROCESSES, THE DIFFERENTIATION OF THE PARTS OF SPEECH, AND THE INTEGRATION OF THE SENTENCE; FROM A STUDY OF INDIAN LANGUAGES; by J. W. Powell.

THE TESTIMONY OF THE ROMANCE LANGUAGES, CONCERNING THE FORMS OF THE IMPERFECT AND PLUPERFECT SUBJUNCTIVE IN THE ROMAN FOLK-SPEECH; by E. A. Fay.

SAVAGE AND CIVILIZED ORTHOEPY; by L. F. Ward.

In philology, North America presents the richest field in the world, for here is found the greatest number of languages distributed among the greatest number of stocks. As the progress of research is necessarily from the known to the unknown, civilized languages were studied by scholars before the languages of savage and barbaric tribes. Again, the higher languages are written and are thus immediately accessible. For such reasons, chief attention has been given to the most highly developed languages. The problems presented to the philologist, in the higher languages, cannot be properly solved without a knowledge of the lower forms. The linguist studies a language that he may use it as an instrument for the interchange of thought; the philologist studies a language to use its data in the construction of a philosophy of language. It is in this latter sense that the higher languages are unknown until the lower languages are studied, and it is probable that more light will be thrown upon the former by a study of the latter than by more extended research in the higher.

The vast field of unwritten languages has been explored but not surveyed. In a general way it is known that there are many such languages, and the geographic distribution of the tribes of men who speak them is known, but scholars have just begun the study of the languages.

That the knowledge of the simple and uncompounded must precede the knowledge of the complex and compounded, that the latter may be rightly explained, is an axiom well recognized in biology, and it applies equally well to philology. Hence any system of philology, as the term is here used, made from a survey of the higher languages exclusively, will probably be a failure. "Which of you by taking thought can add one cubit unto his stature," and which of you by taking thought can add the antecedent phenomena necessary to an explanation of the language of Plato or of Spencer.

The study of astronomy, geology, physics, and biology,

is in the hands of scientific men: objective methods of research are employed and metaphysic disquisitions find no place in the accepted philosophies; but to a large extent philology remains in the hands of the metaphysicians, and subjective methods of thought are used in the explanation of the phenomena observed. If philology is to be a science it must have an objective philosophy composed of a homologic classification and orderly arrangement of the phenomena of the languages of the globe.

Philologic research began with the definite purpose in view to discover in the diversities of language among the peoples of the earth a common element from which they were all supposed to have been derived, an original speech, the parent of all languages. In this philologists had great hopes of success at one time, encouraged by the discovery of the relation between the diverse branches of the Aryan stock, but in this very work methods of research were developed and doctrines established by which unexpected results were reached.

Instead of relegating the languages that had before been unclassified to the Aryan family, new families or stocks were discovered, and this process has been carried on from year to year until scores or even hundreds of families are recognized, and until we may reasonably conclude that there was no single primitive speech common to mankind, but that man had multiplied and spread throughout the habitable earth anterior to the development of organized languages, that is, languages have sprung from innumerable sources after the dispersion of mankind.

The progress in language has not been by multiplication which would be but a progress in degradation under the now well-recognized laws of evolution; but it has been in integration from a vast multiplicity toward a unity. True, all evolution has not been in this direction. There has often been degradation as exhibited in the multiplicity of languages and dialects of the same stock, but evolution in

the aggregate has been integration by progress toward unity of speech, and differentiation (which must always be distinguished from multiplication) by specialization of the grammatic processes and the development of the parts of speech.

When a people once homogeneous are separated geographically in such a manner that thorough inter-communication is no longer preserved, all of the agencies by which languages change act separately in the distinct communities and produce different changes therein and dialects are established. If the separation continues such dialects become distinct languages in the sense that the people of one community are unable to understand the people of another. But such a development of languages is not differentiation in the sense in which this term is here used and often used in biology, but is analogous to multiplication as understood in biology. The differentiation of an organ is its development for a special purpose, *i. e.*, the organic specialization is concomitant with functional specialization. When paws are differentiated into hands and feet, with the differentiation of the organs there is a concomitant differentiation in the functions.

When one language becomes two, the same function is performed by each and is marked by the fundamental characteristic of multiplication, *i. e.*, degradation; for the people originally able to communicate with each other can no longer thus communicate; so that two languages do not serve as valuable a purpose as one. And further, neither of the two languages has made the progress one would have made, for one would have been developed sufficiently to serve all the purposes of the united peoples in the larger area inhabited by them, and, *ceteris paribus*, the language spoken by many people scattered over a large area must be superior to one spoken by a few people inhabiting a small area.

It would have been strange indeed had the primitive assumption in philology been true and the history of language exhibited universal degradation.

In the remarks on the "Origin of Man," the statement was made that mankind was distributed throughout the habitable earth in some geologic period anterior to the present and anterior to the development of other than the rudest arts. Here, again, we reach the conclusion that man was distributed throughout the earth anterior to the development of organized speech.

In the presence of these two great facts the tracing of genetic relationship among human races through arts, customs, institutions and traditions will appear, for all of these must have been developed after the dispersion of mankind. Analogies and homologies in these phenomena must be accounted for in some other way. Somatology proves the unity of the human species; that is the evidence upon which this conclusion is reached is morphologic; but in arts, customs, institutions and traditions abundant corroborative evidence is found. The individuals of the one species though inhabiting diverse climes, speaking diverse languages and organized into diverse communities, have progressed in a broad way by the same stages, have had the same arts, customs, institutions and traditions in the same order, limited only by the degree of progress to which the several tribes have attained and modified only to a limited extent by variations in environment.

If any ethnic classification of mankind is to be established more fundamental than that based upon language, it must be upon physical characteristics, and such must have been acquired by profound differentiation anterior to the development of languages, arts, customs, institutions, and traditions. The classifications hitherto made on this basis are unsatisfactory, and no one now receives wide acceptance. Perhaps farther research will clear up doubtful matters and give an acceptable grouping: or it may be that such research will result only in exhibiting the futility of the effort.

The history of man, from the lowest tribal condition to the highest national organization, has been a history of con-

stant and multifarious admixture of strains of blood ; of admixture, absorption, and destruction of languages with general progress toward unity ; of the diffusion of arts by various processes of acculturation ; and of admixture and reciprocal diffusion of customs, institutions, and traditions. Arts, customs, institutions, and traditions extend beyond the boundaries of languages and serve to obscure them ; and the admixture of strains of blood has obscured primitive ethnic divisions, if such existed.

If the physical classification fails, the most fundamental grouping left is that based on language ; but for the reasons already mentioned and others of like character, the classification of languages is not, to the full extent, a classification of peoples.

It may be that the unity of the human race is a fact so profound that all attempts at a fundamental classification to be used in all the departments of anthropology will fail, and that there will remain multifarious groupings for the multifarious purposes of the science ; or otherwise expressed, that languages, arts, customs, institutions, and traditions may be classified, and that the human family will be considered as one race.

Mythology.

In this department the following papers have been presented :

COMPARATIVE MYTHOLOGY OF THE TWO INDIES ; by Garrick Mallery.

THE "TAR BABY," AND "THE THREE CRANBERRIES"—Two Folk-lore Stories ; by J. W. Powell.

FOUR CREATIONS OF MANKIND—A Túalati Myth ; by A. S. Gatschet.

SUPERSTITIONS ; by A. S. Gatschet.

Here again America presents a rich field for the scientific explorer. It is now known that each linguistic stock has a distinct mythology, and as in some of these stocks there

are many languages differing to a greater or less extent, so there are many like differing mythologies.

As in language, so in mythology, investigation has proceeded from the known to the unknown—from the higher to the lower mythologies. In each step of the progress of opinion on this subject a particular phenomenon may be observed. As each lower status of mythology is discovered it is assumed to be the first in origin, the primordial mythology, and all lower but imperfectly understood mythologies are interpreted as degradations from this assumed original belief. Thus polytheism was interpreted as a degeneracy from monotheism, nature worship from psychotheism, zoölotry from ancestor worship; and in order monotheism has been held to be the original mythology, then polytheism, then physitheism, or nature worship, then ancestor worship.

With a large body of mythologists nature worship is now accepted as the primitive religion; and with another body, equally as respectable, ancestor worship is primordial. But nature worship and ancestor worship are concomitant parts of the same religion, and belong to a status of culture highly advanced and characterized by the invention of conventional pictographs. In North America we have scores or even hundreds of systems of mythology, all belonging to a lower state of culture.

Let us hope that American students will not fall into this line of error by assuming that zoötheism is the lowest stage, because this is the status of mythology most widely spread on the continent.

Mythology is primitive philosophy. A mythology, that is, the body of myths current among any people and believed by them, comprises a system of explanations of all the phenomena of the universe discerned by them; but such explanations are always mixed with much extraneous matter, chiefly incidents in the history of the personages who were the heroes of mythologic deeds.

Every mythology has for its basis a theology—a system of gods who are the actors, and to whom are attributed the phe-

nomena to be explained, for the fundamental postulate in mythology is "some one does it," such being the essential characteristic of subjunctive reasoning. As peoples pass from one stage of culture to another, the change is made by developing a new sociology with all its institutions, by the development of new arts, by evolution of language, and in a degree no less by a change in philosophy; but the old philosophy is not supplanted. The change is made by internal growth and external accretion.

Fragments of the older are found in the newer. This older material in the newer philosophy is often used for curious purposes by many scholars. One such use I wish to mention here. The nomenclature which has survived from the earlier state is supposed to be deeply and occultly symbolic and the mythic narratives to be deeply and occultly allegoric. In this way search is made for some profoundly metaphysic cosmogony, some ancient beginning of the mythology is sought in which mystery is wisdom and wisdom is mystery.

The objective or scientific method of studying a mythology is to collect and collate its phenomena simply as it is stated and understood by the people to whom it belongs. In tracing back the threads of its historical development the student should expect to find it more simple and child-like in every stage of his progress.

It is vain to search for truth in mythologic philosophy, but it is important to search for veritable philosophies that they may be properly compared and that the products of the human mind in its various stages of culture may be known, important in the reconstruction of the history of philosophy and important in furnishing necessary data to psychology. No labor can be more fruitless than the search in mythology for true philosophy and the efforts to build up from the terminology and narratives of mythologies an occult symbolism and system of allegory is but to create a new and fictitious body of mythology.

There is a symbolism inherent in language and found in

all philosophy, true or false, and such symbolism was cultivated as an occult art in the early history of civilization when picture-writing developed into conventional writing; and symbolism is an interesting subject for study but it has been made a beast of burden to carry packs of metaphysic nonsense.

Sociology.

In Sociology the following papers have been presented:

THE OLD ROMAN SENATE: A STUDY OF DELIBERATIVE ASSEMBLIES; by J. Howard Gore.

FRENCH AND INDIAN HALF-BREEDS OF THE NORTHWEST; by Victor Havard.

POISONED WEAPONS OF NORTH AND SOUTH AMERICA; by W. J. Hoffman.

THE DEVELOPMENT OF DELIBERATIVE GOVERNMENT AMONG THE NORTH AMERICAN INDIANS; by J. Howard Gore.

WYANDOT GOVERNMENT: A SHORT STUDY OF TRIBAL SOCIETY; by J. W. Powell.

SCHEME OF THE TENTH CENSUS FOR THE ENUMERATION OF UNTAXED INDIANS; by Garrick Mallery.

CIVILIZATION; by M. B. W. Hough.

Here again North America presents a wide and interesting field to the investigator, for it has within its extent many distinct governments and these governments so far as investigations have been carried, are found to belong to a type more primitive than any of the feudalities from which the civilized nations of the earth sprang as shown by concurrently recorded history.

Yet in this history many facts have been discovered suggesting that feudalities themselves had an origin in something more primitive. In the study of the tribes of the world, a multitude of sociologic institutions and customs have been discovered and in reviewing the history of feudalities it is seen that many of their important elements are survivals from tribal society.

So important are these discoveries that all human history has to be re-written, the whole philosophy of history reconstructed. Government does not begin in the ascendancy of chieftains through prowess in war, but in the slow specialization of executive functions from communal associations based on kinship; deliberative assemblies do not start in councils gathered by chieftains, but councils precede chieftaincies. Law does not begin in contract, but is the development of customs. Land tenure does not begin in grants from the monarch, or the feudal lord, but a system of tenure in common by gentes or tribes is developed into a system of tenure in severalty. Evolution in society has not been from militancy to industrialism, but from organization based on kinship to organization based on property, and alongside of the specializations of the industries of peace the arts of war have been specialized.

So, one by one, the theories of metaphysic writers on sociology are overthrown, and the facts of history are taking their place and the philosophy of history is being erected out of materials accumulating by objective studies of mankind.

Psychology.

One paper on Psychology has been presented, namely :

IS THOUGHT POSSIBLE WITHOUT LANGUAGE?—CASE OF A DEAF MUTE; by Samuel Porter.

Psychology has hitherto been chiefly in the hands of subjective philosophers and is the last branch of Anthropology to be treated by scientific methods. But of late years sundry important labors have been performed with the end in view to give this department of philosophy a basis of objective facts; especially the organ of the mind has been studied and the mental operations of animals have been compared with those of men, and in various other ways the subject is receiving scientific attention.

The new psychology in process of construction will have a three-fold basis: A physical basis on phenomena presented

by the organ of the mind as shown in man and the lower animals; a linguistic basis as presented in the phenomena of language, which is the instrument of mind; a functional basis as exhibited in operations of the mind.

The phenomena of the third class may be arranged in three sub-classes. First, the operations of mind exhibited in individuals in various stages of growth, various degrees of culture, and in various conditions, normal and abnormal; second, the operations of mind as exhibited in technology, arts and industries; third, the operations of mind as exhibited in philosophy; and these are the explanations given of the phenomena of the universe. On such a basis a scientific psychology must be erected.

The transactions of this Society for the past two years exhibit evidence that Anthropology in its various branches is already receiving attention from the objective stand-point; subjective disquisitions find but little place therein and the series of papers constitute a valuable body of contributions to the science.

As methods of study are discovered a vast field opens to the American scholar. Now, as at all times in the history of civilization, there has been no lack of interest in this subject, and no lack of speculative writers; but there is a great want of trained observers and acute investigators.

If we lay aside the mass of worthless matter which has been published and consider only the material used by the most careful writers, we find on every hand that conclusions are vitiated by a multitude of errors of fact of a character the most simple. Yesterday I read an article on the "Growth of Sculpture," by Grant Allen, that was charming; yet therein I found this statement;

So far as I know, the Polynesians and many other savages have not progressed beyond the full-face stage of human portraiture above described. Next in rank comes the drawing of a profile, as we find it among the Eskimos and the bushmen. Our own children soon attain to this level, which is one degree higher than that of the full face, as it implies a special point

of view, suppresses half the features, and is not diagrammatic or symbolical of all the separate parts. Negroes and North American Indians cannot understand profile: they ask what has become of the other eye.

Perhaps Mr Allen derives his idea of the inability of the Indians to understand profiles from a statement of Catlin, which I have seen used for this and other purposes, by different anthropologists until it seems to have become a *favorite fact*.

Turning to Catlin's "Letters and Notes on the Manners, Customs, and Condition of the North American Indians" (Vol. 2, page 2,) we find him saying:

After I had painted these and many more, whom I have not time at present to name, I painted the portrait of a celebrated warrior of the Sioux, by the name of Mah-to-chee-ga, (the little bear,) who was unfortunately slain in a few moments after the picture was done, by one of his own tribe; and which was very near costing me my life for having painted a side view of his face, leaving one-half of it out of the picture, which had been the cause of the affray; and supposed by the whole tribe to have been intentionally left out by me, as "good for nothing." This was the last picture that I painted amongst the Sioux, and the last, undoubtedly, that I shall ever paint in that place. So tremendous and so alarming was the excitement about it, that my brushes were instantly put away, and I embarked the next day on the steamer for the sources of the Missouri, and was glad to get under weigh.

Subsequently Mr. Catlin elaborates this incident into the "Story of the Dog," Vol. 2, page 188 *et seq.*

Now, whatsoever of truth or of fancy there may be in this story, it cannot be used as evidence that the Indians could not understand or interpret profile pictures, for Mr. Catlin himself gives several plates of Indian pictographs exhibiting profile faces. In my cabinet of pictographs I have hundreds of side views made by Indians of the same tribe of which Mr. Catlin was speaking.

It should never be forgotten that travelers and other persons who write for the sake of making good stories must be used with the utmost caution. Catlin is only one of a thousand such who can be used with safety only by persons so thoroughly acquainted with the subject that they are able

to divide facts actually observed from creations of fancy. But Mr. Catlin must not be held responsible for illogical deductions even from his facts. I know not how Mr. Allen arrived at his conclusion, but I do know that pictographs in profile are found among very many, if not all the tribes of North America.

Now, for another example. Peschel, in "The Races of Man" (page 151), says :

The transatlantic history of Spain has no case comparable in iniquity to the act of the Portuguese in Brazil, who deposited the clothes of scarlet fever or small-pox patients on the hunting grounds of the natives, in order to spread the pestilence among them; and of the North Americans, who used strychnine to poison the wells which the Redskins were in the habit of visiting in the deserts of Utah; of the wives of Australian settlers, who, in times of famine, mixed arsenic with the meal which they gave to starving natives.

In a foot note on the same page, Burton is given as authority for the statement that the people of the United States poisoned the wells of the redskins.

Referring to Burton, in "The City of the Saints" (page 474), we find him saying :

The Yuta claim, like the Shoshonee, descent from an ancient people that immigrated into their present seats from the northwest. During the last thirty years they have considerably decreased according to the mountaineers, and have been demoralized mentally and physically by the emigrants; formerly they were friendly, now they are often at war with the intruders. As in Australia, arsenic and corrosive sublimate in springs and provisions have diminished their number.

Now, why did Burton make this statement? In the same volume he describes the Mountain Meadow massacre, and gives the story as related by the actors therein. It is well known that the men who were engaged in this affair tried to shield themselves by diligently publishing that it was a massacre by Indians incensed at the travelers because they had poisoned certain springs at which the Indians were wont to obtain their supplies of water. When Mr. Burton was in Salt Lake City he doubtless heard these stories.

So the falsehoods of a murderer, told to hide his crime,

have gone into history as facts characteristic of the people of the United States in their treatment of the Indians. In the paragraph quoted from Burton some other errors occur. The Utes and Shoshonis do not claim to have descended from an ancient people that immigrated into their present seats from the northwest. Most of these tribes, perhaps all, have myths of their creation in the very regions now inhabited by them.

Again, these Indians have not been demoralized mentally or physically by the emigrants, but have made great progress toward civilization.

The whole account of the Utes and Shoshonis given in this portion of the book is so mixed with error as to be valueless, and bears intrinsic evidence of having been derived from ignorant frontiersmen.

Turning now to the first volume of Spencer's *Principles of Sociology* (page 149) we find him saying:

And thus prepared, we need feel no surprise on being told that the Zuñi Indians require "much facial contortion and bodily gesticulation to make their sentences perfectly intelligible;" that the language of the Bushman needs so many signs to eke out its meaning, that "they are unintelligible in the dark;" and that the Arapahos "can hardly converse with another in the dark."

When people of different languages meet, especially if they speak languages of different stocks, a means of communication is rapidly established between them composed partly of signs and partly of oral words, the latter taken from one or both of the languages but curiously modified so as hardly to be recognized. Such conventional languages are usually called "jargons," and their existence is rather brief.

When people communicate with each other in this manner oral speech is greatly assisted by sign language, and it is true that darkness impedes their communication. The great body of frontiersmen in America who associate more or less with the Indians depend upon jargon methods of communication with them; and so we find that various writers and travellers describe Indian tongues by the characteristics of this jargon speech. Mr. Spencer usually does.

The Zuñi and the Arapaho Indians have a language with a complex grammar and copious vocabulary well adapted to the expression of the thoughts incident to their customs and status of culture, and they have no more difficulty in conveying their thoughts with their language by night than Englishmen have in conversing without gaslight. An example from each of three eminent authors has been taken to illustrate the worthlessness of a vast body of anthropologic material to which even the best writers resort.

Anthropology needs trained devotees with philosophic methods and keen observation to study every tribe and nation of the globe almost *de novo*; and from materials thus collected a science may be established.

CONSTITUTION.

ARTICLE I.—*Name.*

The name of this Society shall be "THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON."

ARTICLE II.—*Object.*

The object of this Society shall be to encourage the study of the Natural History of Man, especially with reference to America, and shall include Archæology, Somatology, Ethnology, and Philology.

ARTICLE III.—*Members.*

The members of this Society shall be persons who are interested in Anthropology, and shall be divided into three classes: Active, Corresponding, and Honorary. The Active members shall be those who reside in Washington, or in its vicinity, and who shall pay the dues required by Article XV; Corresponding members shall be those who are engaged in anthropological investigations in other localities; Honorary members shall be those who have contributed by authorship or patronage to the advancement of Anthropology. Corresponding or Honorary members may become Active members by paying the fee required by Article XV.

All members shall be elected by ballot, as follows: The name of the candidate shall be recommended to the Council in writing, by two members. If a majority of the Council favor the election, the name shall be presented to the Society, and a vote of a majority of the Active members present at a regular meeting shall be necessary to an election.

No person shall be entitled to the privileges of Active membership before signing this constitution.

ARTICLE IV.—*Officers.*

The officers of this Society shall be a President, four Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and a Curator, all of whom, together with six other Active members, shall constitute a Council, all to be elected by ballot at each annual meeting. The officers shall serve for one year, or until their successors are elected.

ARTICLE V.—*The Council.*

No business shall be transacted by the Society, and no communication received or published in the name of the Society, that has not first been referred to the Council, five members of which shall constitute a quorum.

They shall act upon all nominations for membership, shall have direction of the finances, audit the accounts of the Treasurer, Corresponding Secretary, and Curator, and provide a proper programme for regular and special meetings. They shall meet one hour before the regular sessions of the Society, and at such other times as they may be called together by the President. They may call special meetings of the Society.

ARTICLE VI.—*The Sections.*

For active operations the Society shall be divided into four sections, as follows: Section A, Archæology; Section B, Somatology; Section C, Ethnology; Section D, Philology. The Vice-Presidents of the Society shall be *ex officio* chairmen of these sections respectively, and shall be designated by the President to their sections after their election. It shall be the duty of these sections to keep the Society informed upon the progress of research in their respective fields, to make special investigations when requested by the Council

to announce interesting discoveries, to collect specimens, manuscripts, publications, newspaper clippings, &c., and in every way to foster their divisions of the work.

All papers presented to the sections shall be referred to the Council and through it to the Society.

ARTICLE VII.—*The President.*

The President, or in his absence, one of the Vice-Presidents, shall preside over the meetings of the Society and of the Council, and shall appoint all committees in the Council and in the Society.

ARTICLE VIII.—*The Vice-Presidents.*

The Vice-Presidents shall respectfully preside over the sections to which they have been designated, and represent such section in the Council and in the Society.

All papers from a section shall be referred to the Council through its Vice-President.

ARTICLE IX.—*The Corresponding Secretary.*

It shall be the duty of the Corresponding Secretary to receive and answer all letters of the Society, to give due notice of all meetings, regular and special, to receive all donations to the Society other than money, acknowledge the receipt thereof, and deliver them to the Curator.

ARTICLE X.—*The Recording Secretary.*

The Recording Secretary shall keep the minutes of the regular and special meetings of the Society, and of the Council; shall keep a list of Active, Corresponding and Honorary members, with their residences, and shall inspect and count all ballots.

ARTICLE XI.—*Duties of the Treasurer.*

The Treasurer shall receive and have charge of all moneys;

he shall deposit the funds as directed by the Council, and shall not expend any money except as ordered by the Council. He shall notify members in writing when their dues have remained unpaid for six months.

ARTICLE XII.—*The Curator.*

The Curator shall have charge of all books, pamphlets, photographs, clippings, and other anthropological material not deposited in accordance with Article XVI, in the National Museum or the Army Medical Museum; he shall keep a record of them in a book provided by the Society; he shall keep a card subject index of anthropological facts, to which the members are all expected to contribute.

ARTICLE XIII.—*Meetings.*

The regular meetings of the Society shall be held on the first and third Tuesday of each month from October to June inclusive. An annual meeting for the election of officers shall be held on the third Tuesday of January in each year, at which only active members who are not in arrears for fees shall be entitled to vote. The business of the Society shall be conducted in accordance with the established rules of parliamentary practice. Papers read shall be limited to twenty minutes, after which the subject shall be thrown open for discussion, remarks thereon to be limited to five minutes for each speaker. At the first meeting in February the retiring president shall deliver an address upon the work of the Society during the preceeding year. Ten active members present at any meeting shall constitute a quorum.

ARTICLE XIV.—*Visitors.*

Members may invite strangers interested in Anthropology to attend any meeting excepting the annual election; but a resident of the District of Columbia shall not be invited

ARTICLE XV.—*Fees.*

more than once during a year, except with the consent of the Council.

Each member, on joining, shall pay the sum of two dollars, and two dollars for each year thereafter, commencing with the first of January ensuing. The names of members failing to pay their fees one month after written notice from the Treasurer as provided in Article XI, shall be dropped from the roll.

ARTICLE XVI.—*Donations.*

It shall be the duty of all members to seek to increase and perfect the materials of anthropological study in the national collections at Washington. All donations of specimens, books, pamphlets, maps, photographs, and newspaper clippings shall be received by the Corresponding Secretary and delivered to the Curator, who shall exhibit them before the Society at the next regular meeting after their reception, and shall make such abstract or entry concerning them in a book provided by the Society, as will secure their value as materials of research; after which all archæological and ethnological materials shall be deposited in the National Museum, in the name of the donor and of the Society; all crania and somatic specimens in the Army Medical Museum; all books, pamphlets, photographs, clippings, and abstracts in the archives of the Society.

ARTICLE XVII.—*Amendments.*

This constitution shall not be amended except by a three-fourths vote of the active members present at the annual meeting for the election of officers, and after notice of the proposed change shall have been given in writing at a regular meeting of the Society, at least one month previously.

ARTICLE XVIII.—*Order of Business.*

The order of business at each regular meeting shall be:

1. Reading of the minutes of the last meeting.
2. Report of the Council upon membership.
3. Report of the Corresponding Secretary.
4. Report of the Curator.
5. Reading of papers and discussions.
6. Notes and queries.

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1881.

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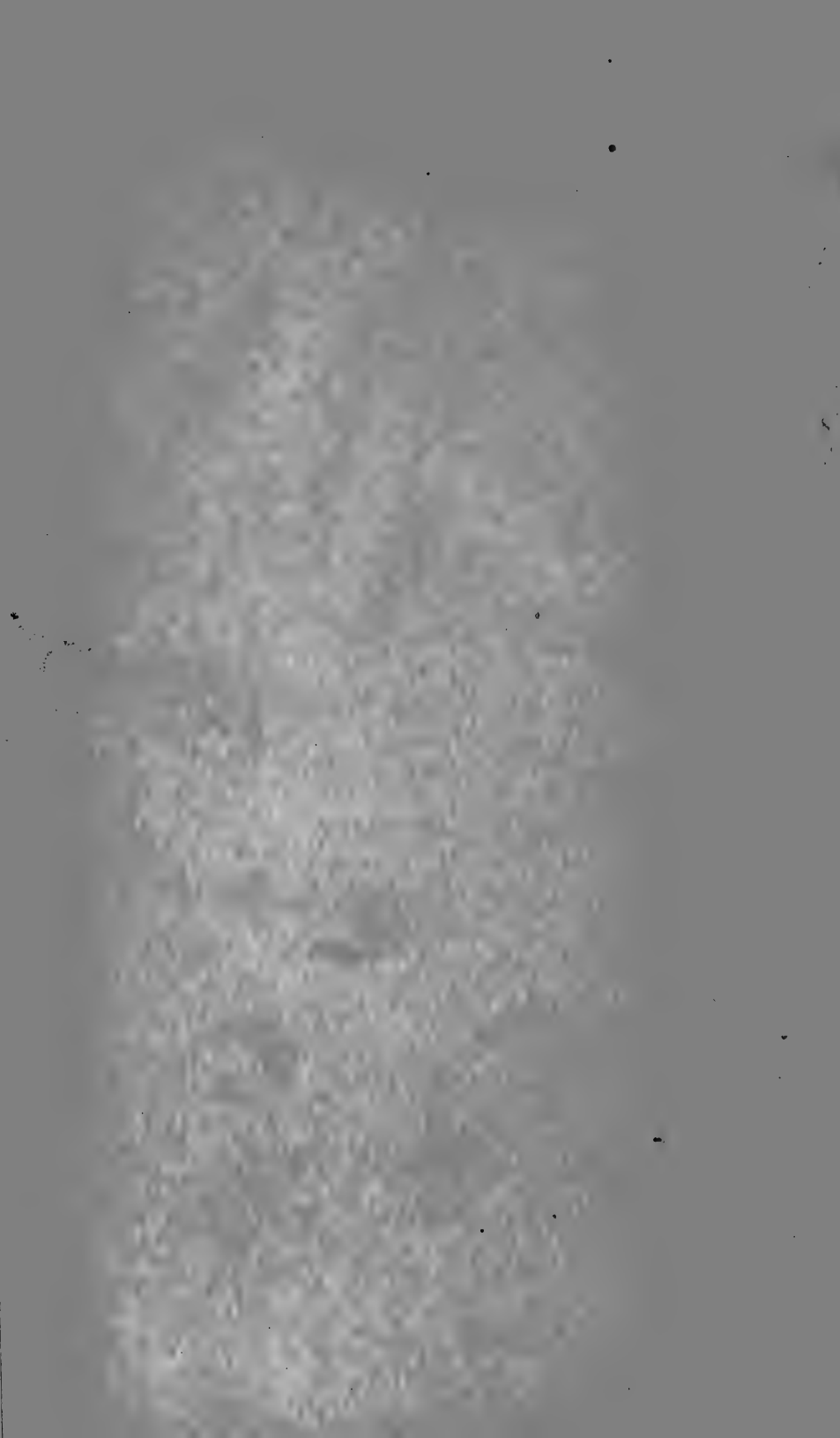
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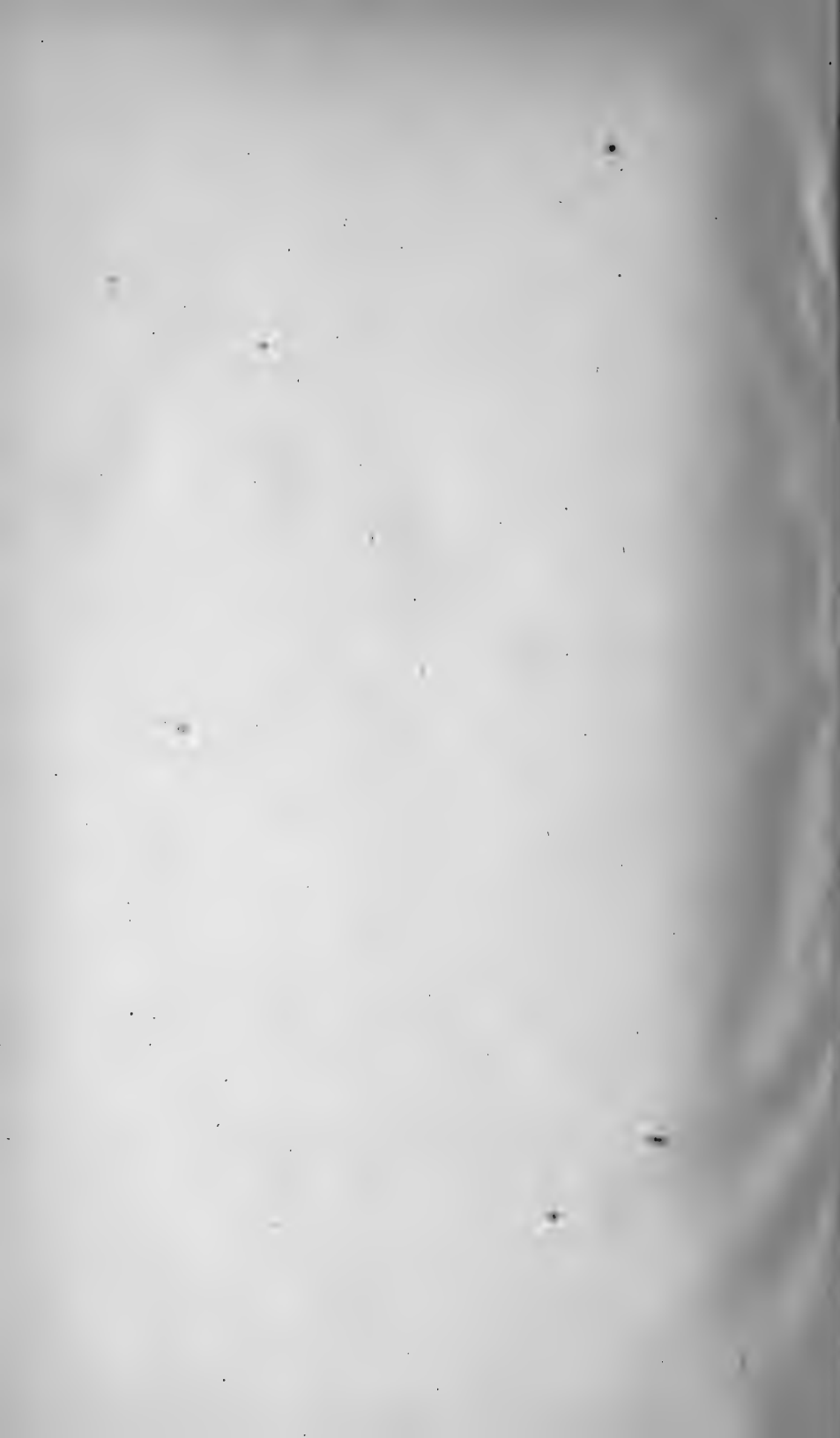
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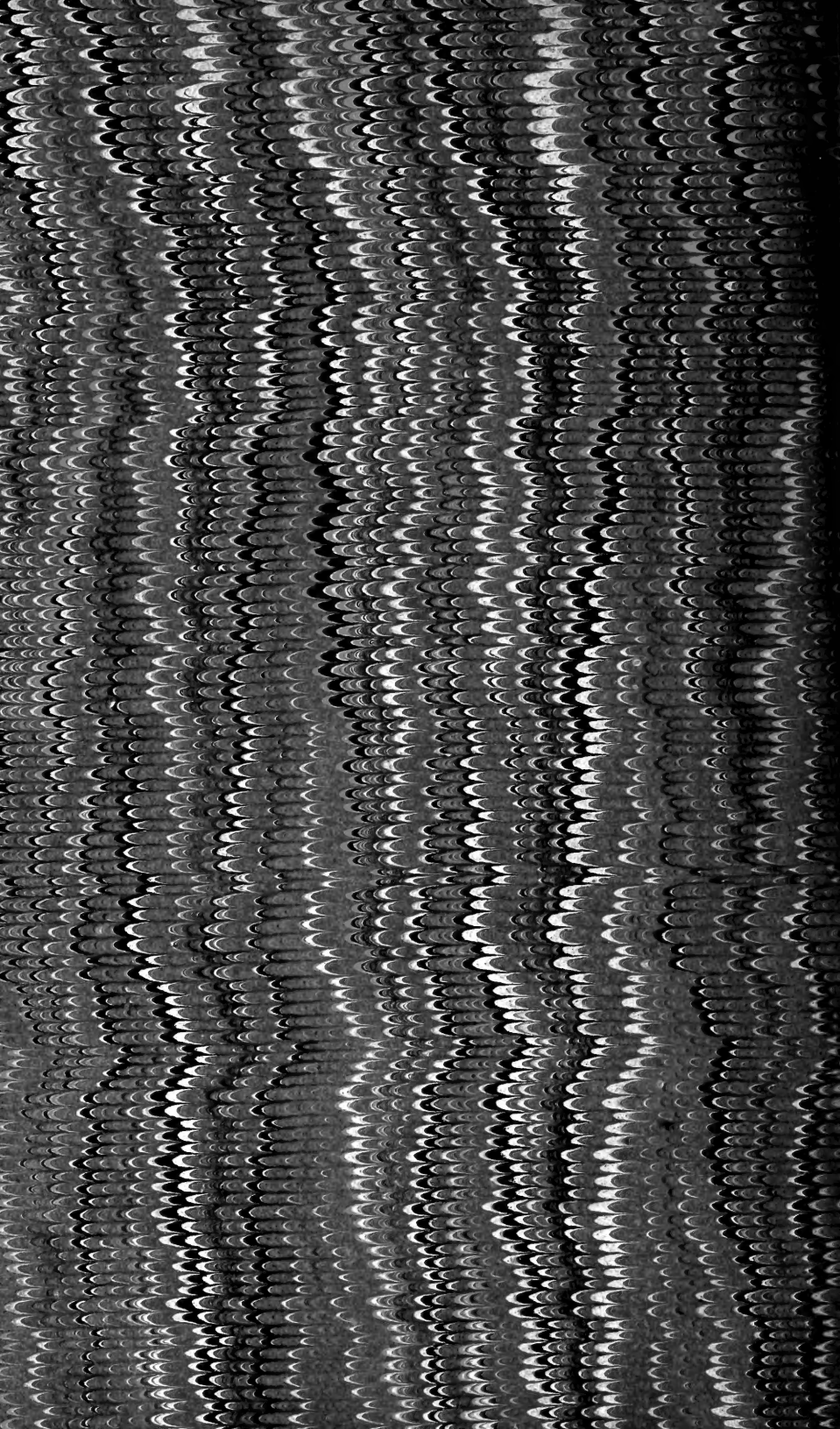


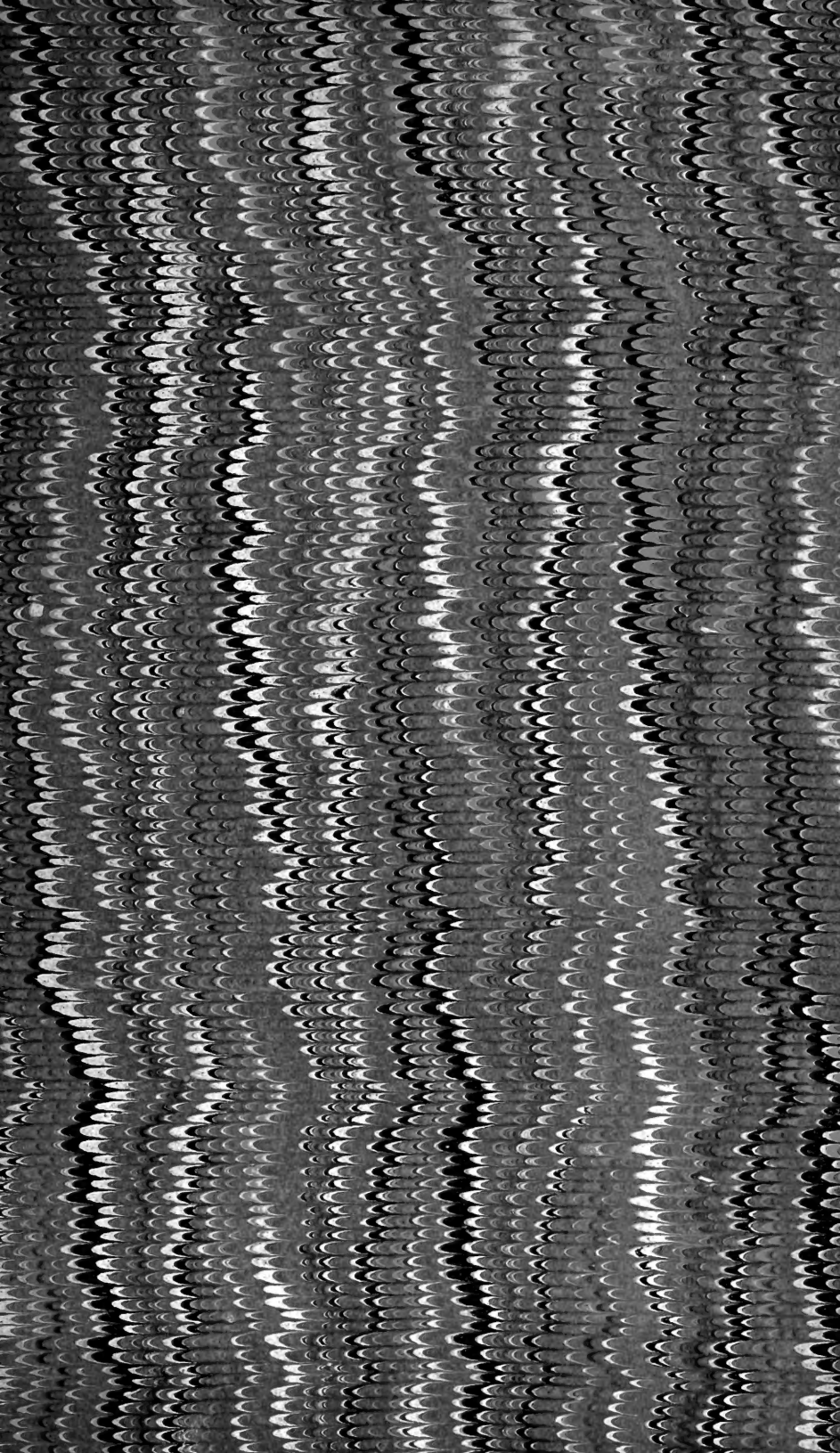












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